Series 1960, No. 17 Issued March 1964

SOIL SURVEY

Cochran County Texas

OUR SOIL ★ OUR STRENGTH

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
TEXAS AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

THIS SURVEY will serve several groups of readers. It will help farmers and ranchers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; serve as a reference for students and teachers; and add to our knowledge of soils.

Locating the Soils

Use the index to map sheets to locate areas on the large map. The index is a small map of the county on which numbered rectangles have been drawn to show what part of the county is represented on each sheet of the large map. The boundaries of the soils are outlined on the soil map, and there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil, wherever they appear on the map. The symbol is inside the area if there is enough space; otherwise, it is outside the area and a pointer shows where it belongs.

Suppose, for example, an area located on the map has the symbol AfA. The legend for the detailed map shows that this symbol identifies Amarillo fine sandy loam, 0 to 1 percent slopes. This soil and all others mapped in the county are described in the section "Descriptions of the Soils."

Finding Information

Different parts of the soil survey report will be of particular interest to different groups of readers.

Farmers and ranchers can learn about the soils in the section "Descriptions of the Soils" and then turn to the section "Use and Management of the Soils." In this way they first identify the soils on their farms and then learn how these soils can be managed and what yields can be expected. The soils are grouped by capability units, which are groups of soils that need similar management and respond in about the same way. Amarillo fine sandy loam, 0 to 1 percent slopes, for example, is in capability unit IIIe-1 if not irrigated and in capability unit IIe-2 if irrigated. The capability units are discussed in the section "Use and Management of the Soils."

Ranchers who want information about management of native range can turn to the section "Range Management." In this section the soils are arranged by range sites, and some suggestions for range management and estimates of productivity are given. Amarillo fine sandy loam, 0 to 1 percent slopes, is in the Mixed Land range site.

The "Guide to Mapping Units" at the back of the report will simplify the use of the map and the report. The guide gives the name and map symbol for each soil and the page on which the soil is described, and also the capability unit and range site in which the soil has been placed and the pages on which these are described.

Engineers will want to refer to the section "Engineering Applications." Tables in that section show characteristics of the soils that affect engineering.

Soil scientists and others interested in the scientific aspect of the soils will find information about how the soils were formed and how they are classified in the section "Formation, Classification, and Morphology of the Soils."

Students, teachers, and other users will find information about the soils and their management in various parts of the report, depending on their particular interest.

Newcomers to Cochran County will be especially interested in the section "General Soil Map," which describes the broad patterns of soils. They may also wish to read the section "General Nature of the County," which gives general information about the county.

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This cooperative soil survey was made by the United States Department of Agriculture and the Texas Agricultural Experiment Station to provide a basis for determining the best agricultural uses of the soils. The Soil Conservation Service completed the fieldwork in 1960. Unless otherwise specified, all statements in this report refer to conditions at that time. The soil survey is part of the technical assistance furnished to the Cochran Soil Conservation District.

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SOIL SURVEY OF COCHRAN COUNTY, TEXAS

BY ALLEN L. NEWMAN, SOIL CONSERVATION SERVICE

SURVEY BY ANSELL W. OUTLAW, IN CHARGE, JAMES W. GREEN, CHARLES L. GIRDNER, AND WAYNE E. RICHARDSON, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE TEXAS AGRICULTURAL EXPERIMENT STATION

COCHRAN COUNTY is in the High Plains physiographic area of the southern Great Plains. It adjoins Lea and Roosevelt Counties, New Mexico. The county covers an area of 501,120 acres. It is about 26 miles east to west and 30 miles north to south (fig. 1).

The area as a whole is a nearly level to gently undulating plain that slopes upward from about 3,600 feet in the southeast to 4,000 feet in the northwest.

About half of the county is cultivated, and more than 65,000 acres is irrigated cropland. Cotton and grain sorghum are the principal crops. About 75,000 acres is planted to cotton and 150,000 acres to grain sorghum. Other crops grown are small grain, alfalfa, sesame, and some grasses for seed.

How Soils Are Named, Mapped, and Classified

Soil scientists made this survey to learn what kinds of soils are in Cochran County, where they are located, and how they can be used. They went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; kinds of crops or native plants; kinds of rock; and many facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the rock material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to uniform procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, the major horizons of all the soils of one series are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Lubbock and Portales, for example, are the names of two soil series represented in Cochran County. All the soils in the United States having the same series name are essentially alike in natural characteristics.

Many soil series contain soils that differ in the texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Portales fine sandy loam and Portales loam are two soil types in the Portales series. The difference in the texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into soil phases. The name of a soil phase indicates a feature that affects management. For example, Portales fine sandy loam, 0 to 1 percent slopes, is one of two phases of

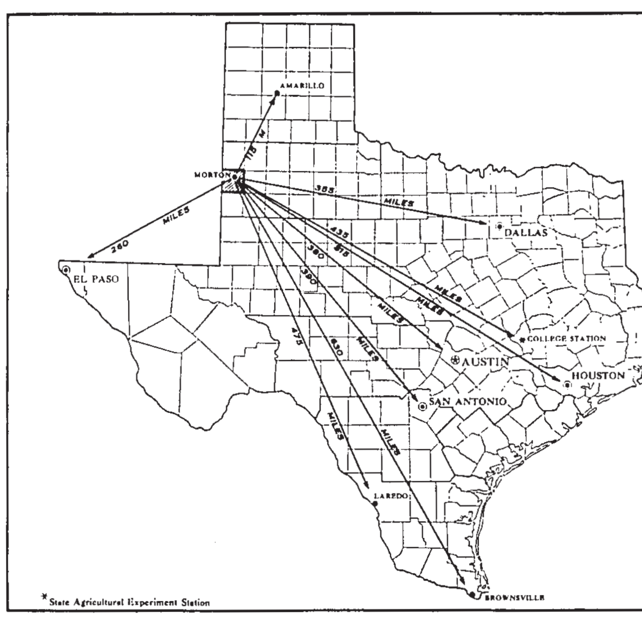

Figure 1.—Location of Cochran County in Texas.

Portales fine sandy loam, a soil type that has a slope range of 0 to 3 percent.

After a fairly detailed guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. These photographs show grasslands, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientist has a problem of delineating areas where different kinds of soils are so intricately mixed or occur in such small individual tracts that it is not practical to show them separately on the map. Therefore, he shows this mixture of soils as one mapping unit and calls it a soil complex. Ordinarily, a soil complex is named for the major soil series in it, for example, Berthoud-Potter complex. Occasionally two or more soils that are not geographically associated are shown as one mapping unit, if the differences between the soils are not sufficient to justify separation for the purposes of the soil survey report. Such a mapping unit is called an undifferentiated group. Gomez and Portales soils is an example.

Only part of the soil survey was done when the soil scientist had named and described the soil series and mapping units and had shown the location of the mapping units on the soil map. He still had to present the mass of detailed information he had recorded in different ways for different groups of users, among them farmers, managers of rangelands, and engineers.

To do this efficiently, he had to consult with persons in other fields of work and with them prepare groupings that would be of practical value to the different users. Such groupings are the capability classes, subclasses, and units, designed primarily for those interested in producing the short-lived crops and tame pasture; range sites, for those using large tracts of native grass; and the classifications used by engineers who build highways or structures to conserve soil and water.

General Soil Map

After study of the soils in a locality and the way they are arranged, it is possible to make a general map that shows several main patterns of soils, called soil associations. Such a map is the colored general soil map in the back of this report. Each association, as a rule, contains a few major soils and several minor soils, in a pattern that is characteristic although not strictly uniform.

The soils within any one association are likely to differ from each other in some or in many properties; for example, slope, depth, stoniness, or natural drainage. Thus, the general soil map shows, not the kind of soil at any particular place, but patterns of soils, in each of which there are several different kinds of soils.

Each soil association is named for the major soil series in it, but, as already noted, soils of other series may also be present. The major soils of one soil association may also be present in other associations, but in different patterns.

The general map showing patterns of soils is useful to people who want a general idea of the soils, who want to compare different parts of a county, or who want to know the possible location of good-sized areas suitable for a certain kind of farming or other land use.

1. Amarillo loamy fine sand association: Sandy land

This association consists of broad areas of nearly level and gently undulating soils. It is about 204,000 acres in extent. It includes, in addition to the dominant Amarillo loamy fine sand, areas of Amarillo fine sandy loam, Randall fine sandy loam, Gomez loamy fine sand, Portales loamy fine sand, and Brownfield fine sand (fig. 2). Amarillo loamy fine sand is a deep soil that has a brown surface layer and a friable, red or reddish-brown subsoil. The Amarillo fine sandy loam in this association is nearly level and is slightly lower in the landscape than Amarillo loamy fine sand. Randall fine sandy loam is in small playas. Many of these playas are surrounded by Gomez and Portales soils, which are underlain by chalky caliche. Most of the Brownfield fine sand in this association is the thin surface phase. It occurs in areas of transition between large areas of Brownfield fine sand, thick surface, and Amarillo loamy fine sand.

About 40 percent of this association is cultivated, and nearly 25 percent of the cultivated acreage is irrigated by means of sprinklers. The rangeland, if properly managed, produces good yields of mid and tall grasses. Among the invading shrubs are mesquite, catclaw, shin oak, and sand sagebrush. A good system of managing crop residue is needed to protect cropland against wind erosion, and careful regulation of grazing is needed to protect grassland.

2. Amarillo fine sandy loam association: Mixed land

This association consists of broad areas of nearly level to gently sloping soils. It is about 185,000 acres in extent. In addition to the dominant Amarillo fine sandy loam, it includes areas of Arvana, Drake, Lubbock, Mansker, Portales, Zita, and Randall soils (fig. 3). Arvana soils have a layer of rocklike caliche 1 to 3 feet below the surface. Mansker soils are shallow and calcareous. Portales and Zita soils are underlain by chalky caliche. Lubbock soils are in slight depressions. The light-colored, limy Drake soils occur as dunes to the east of playas. The dark-colored, clayey Randall soils are in playas. Most of the playas in the county are in this soil association.

About 60 percent of this association is cultivated, and about 30 percent of the cultivated acreage is irrigated. The Amarillo soil is productive, but it needs protection against wind erosion. The rangeland, if properly managed, produces good yields of mid and short grasses. Among the invading shrubs are mesquite and catclaw.

3. Brownfield-Tivoli fine sand association: Deep sands

This association consists of duned and gently undulating soils. It is in the western and southern parts of the county and is about 75,000 acres in extent. The duned areas are Tivoli fine sand, and the gently undulating areas are Brownfield fine sand, thick surface (fig. 4).

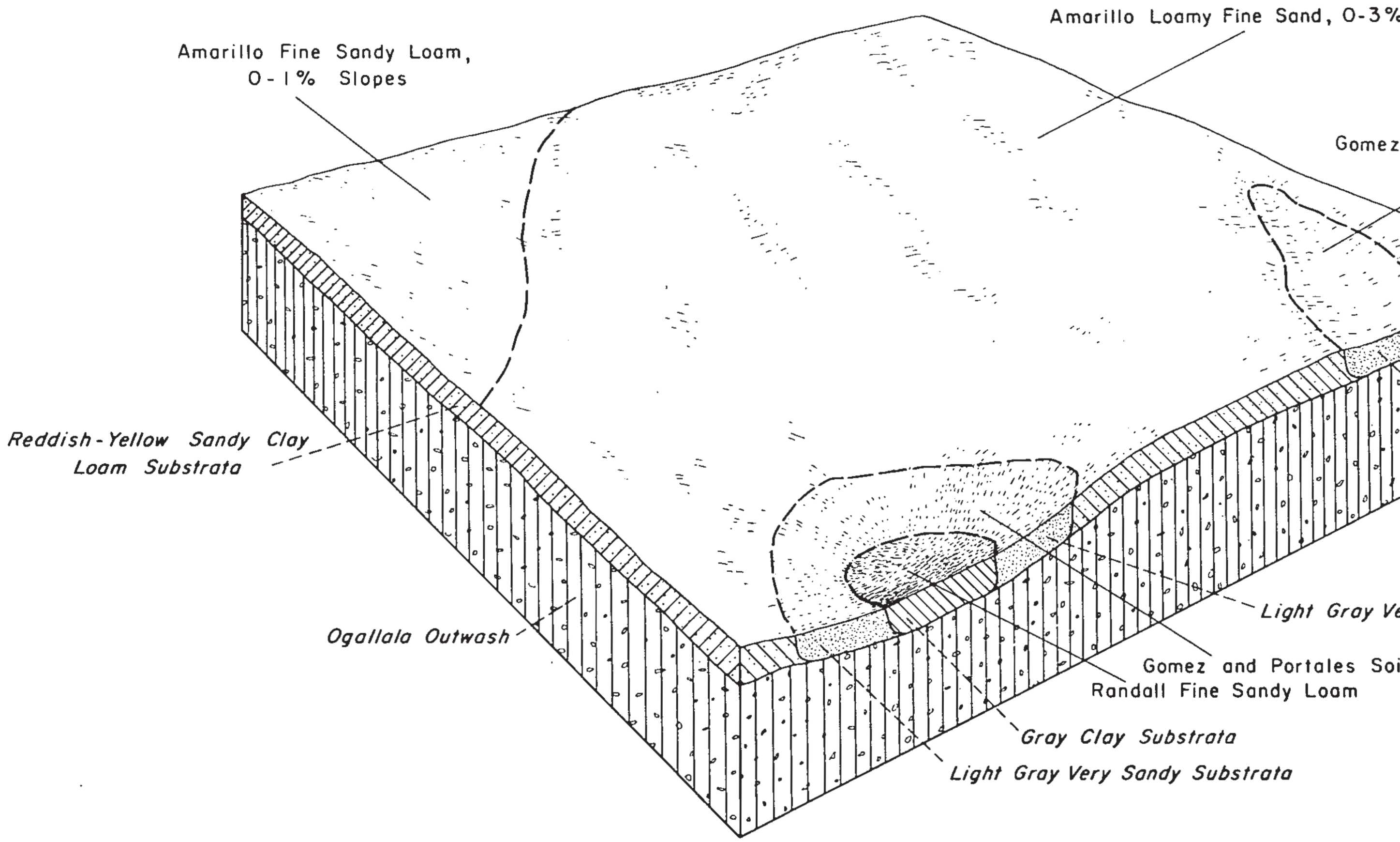

Figure 2.—Typical pattern of soils in association 1. (Randall fine sandy loam at lower right is the thick surface v

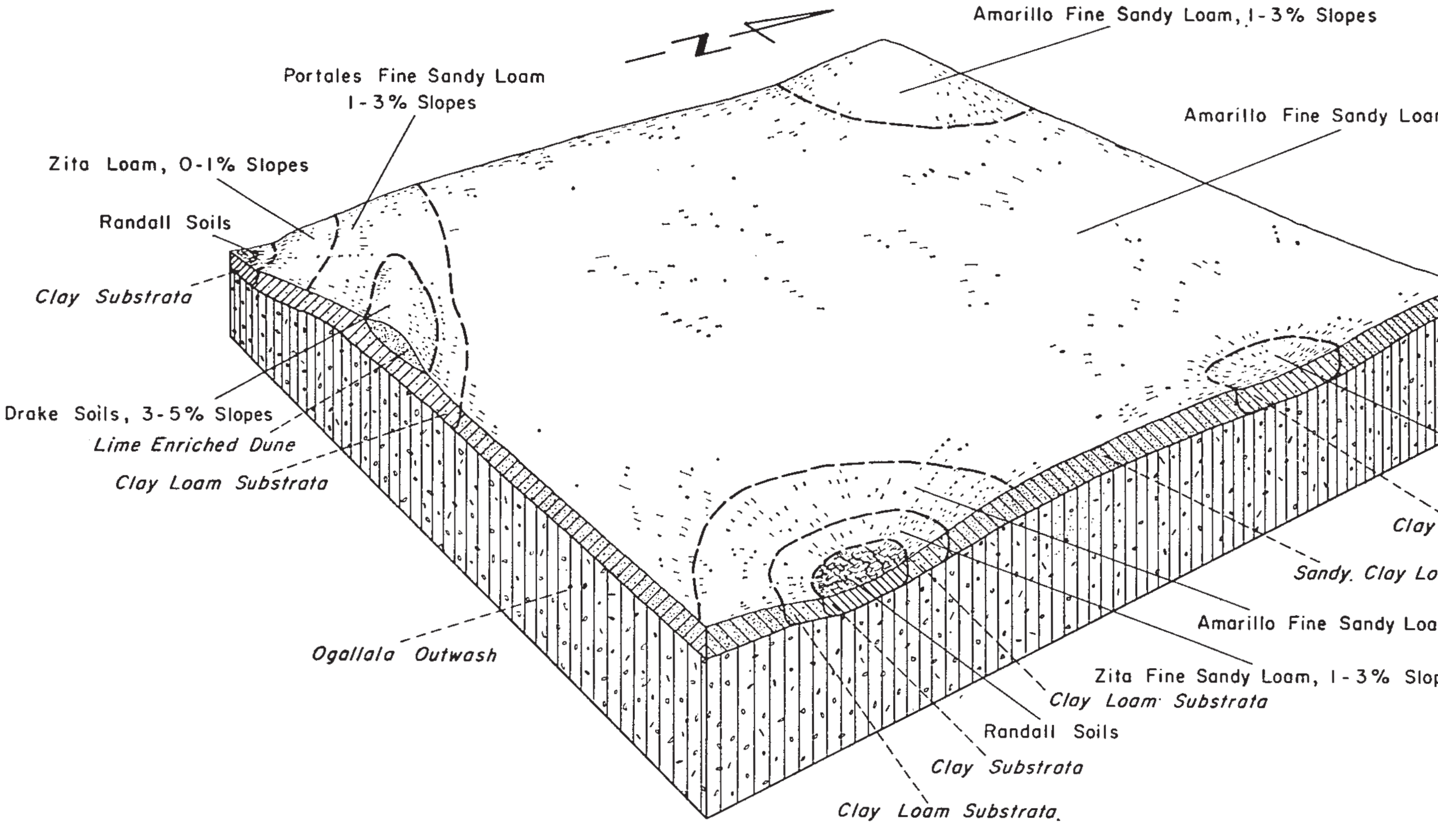

Figure 3.—Typical pattern of soils in association 2.

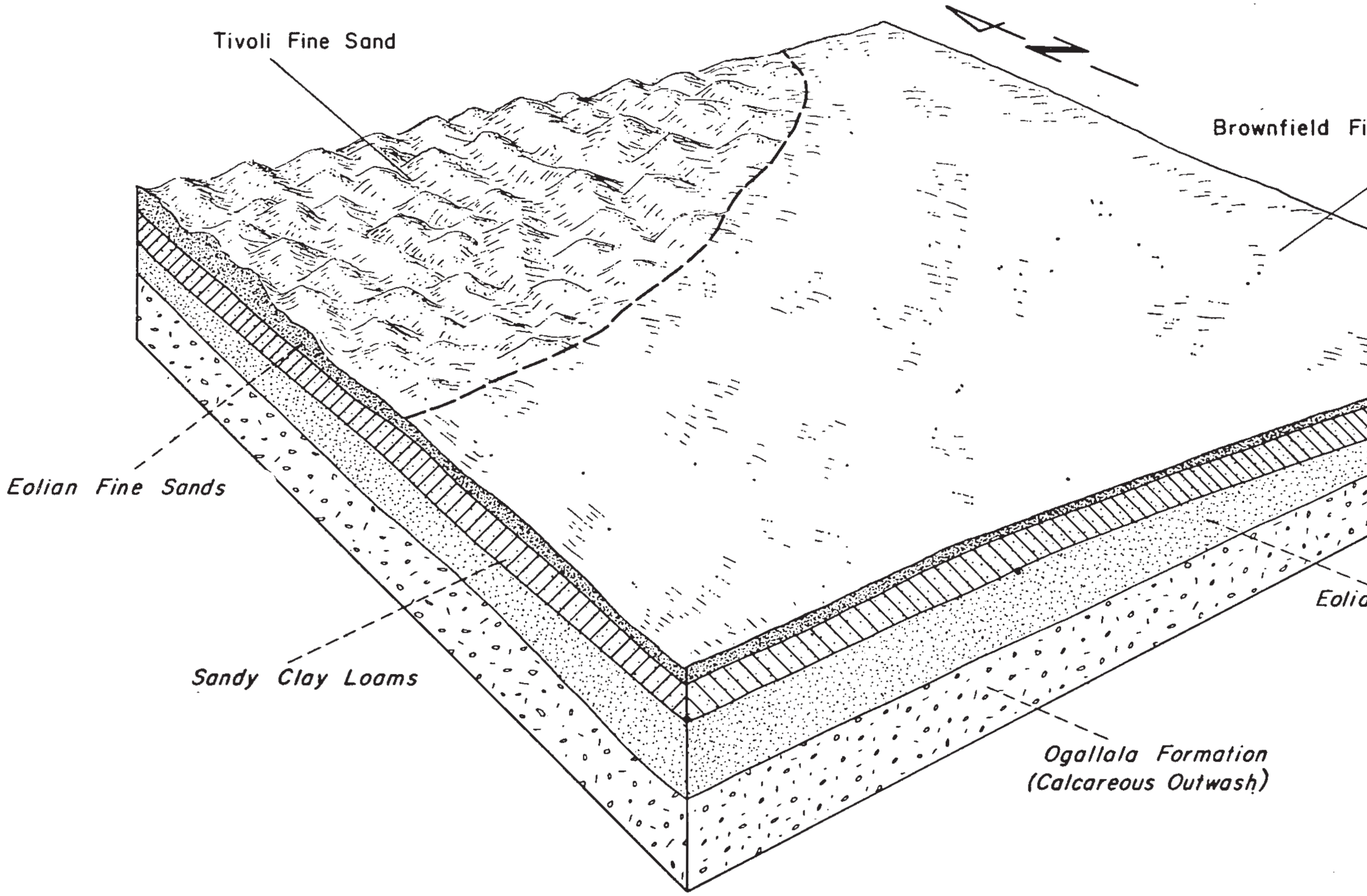

Figure 4.—Typical pattern of soils in association 3.

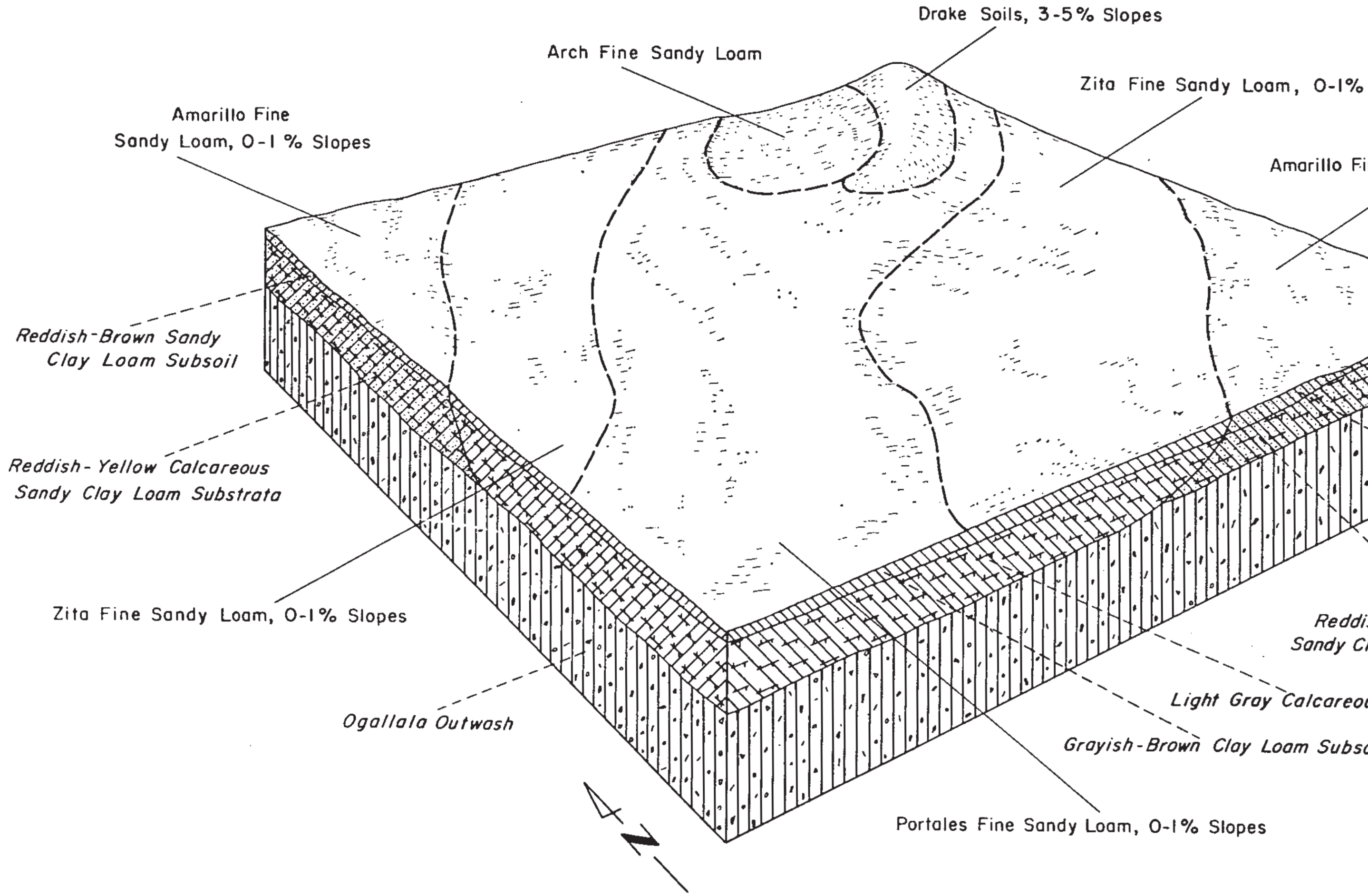

Figure 5.—Typical pattern of soils in association 4. Amarillo fine sandy loam, 0 to 1 percent slopes, is in association 2, which

Most of this association is part of large ranches and is used as range. If properly managed, the soils produce good yields of tall grass. Among the invading shrubs are shin oak, sand sagebrush, skunkbush, and yucca. A small proportion of the acreage is cultivated, although the hazard of wind erosion is severe. Some cultivated areas have been abandoned or reseeded to grass.

4. Portales-Zita association: Calcareous soils

This association consists of soils in broad, shallow valleys. It is a little more than 37,000 acres in extent. The largest areas are in the northeastern and northwestern parts of the county. There are small areas near the southwestern corner. In addition to the dominant Portales and Zita soils, the association includes areas of Arch, Drake, and Mansker soils (fig. 5). More than half the acreage consists of Portales soils, which are calcareous to the surface. About a third of the acreage consists of Zita soils, which are darker colored than Portales soils and are noncalcareous to a depth of about 18 inches. Both Portales and Zita soils have a layer of soft, chalky caliche at a depth of 24 to 30 inches. Arch soils, which are in low spots, are very limy and have a chalky layer at a depth of about 15 inches. Drake soils occur as low dunes; they have slopes of as much as 8 percent. In general, slopes in this association are no more than 2 percent.

About 75 percent of this association is cultivated, and nearly 40 percent of the cultivated acreage is irrigated. On the rangelands, the vegetation consists mostly of short grass. The rangelands are generally free of invading shrubs.

Zita soils are productive; Portales soils are productive if irrigated; the other soils in this association are better suited to range than to cultivated crops. Free lime in the soils increases their susceptibility to wind erosion.

Figure 6.—**Caliche layer in Amarillo fine sandy loam. Upper boundary is wavy.**

Descriptions of the Soils

This section is provided for those who want detailed information about the soils in the county. It describes the series and the mapping units within each series. For more general information about the soils, the reader can refer to the section "General Soil Map," in which the broad patterns of soils are described. The acreage and proportionate extent of each soil mapped in the county are given in table 1. Their location is shown on the soil map at the back of the report.

Layers that contain accumulations of calcium carbonate are a major feature of most of the soils in Cochran County. About 80 percent of the total acreage is underlain by what is locally called caliche. In some soils, the Arvana for example, this layer is very hard; in others it is soft and chalky, as in the Zita soils. In some soils this layer is several feet thick, and in others it is only a few inches thick. The upper boundary is smooth or wavy (fig. 6). Ordinarily, the lower boundary is diffuse. The uppermost few inches may be slightly cemented.

Amarillo Series

The Amarillo series consists of deep, friable, dark-colored, neutral to mildly alkaline soils on uplands.

The surface layer of Amarillo soils ranges from 6 to 14 inches in thickness, from loam to loamy fine sand in texture, and from brown to reddish brown in color. It has a weak granular structure unless plowing has destroyed the structure. The sandier soils have the browner colors and the thicker surface layers.

The subsoil contains more clay than the surface layer. It consists of light sandy clay loam or heavy sandy clay loam. It has two layers. The upper 10 to 20 inches is reddish brown and free of lime; it has a moderate, coarse, prismatic structure that breaks to subangular blocks or granules. The lower layer ranges from 10 to 50 inches in thickness. Ordinarily, it contains less clay than the upper layer. In color, it ranges from yellowish red or reddish yellow to red or, in places, reddish brown. It has a weak, coarse, prismatic structure, and it is generally calcareous.

Below the subsoil, and forming the upper part of the substratum, is a caliche layer that ranges from 6 to 36 inches in thickness but is commonly about 18 inches thick. This layer is thinnest where the slope is strongest. The caliche is generally pink but ranges from pinkish white to yellowish red. Ordinarily it is friable, but it may be slightly hardened in some places. Beneath the caliche, the parent material consists of reddish-yellow, calcareous, friable, moderately sandy sediments that have been reworked by wind.

TABLE 1.--APPROXIMATE ACREAGE AND PROPORTIONATE EXTENT OF SOILS

Symbol	Soil	Cropland: Irrigated	Cropland: Nonirrigated	Range	Other	Total	Proportionate extent
		Acres	Acres	Acres	Acres	Acres	Percent
AfA	Amarillo fine sandy loam, 0 to 1 percent slopes	24,194	57,783	43,853	4,489	130,319	26.0
AfB	Amarillo fine sandy loam, 1 to 3 percent slopes	5,593	19,039	19,902	662	45,196	9.0
AfC	Amarillo fine sandy loam, 3 to 5 percent slopes	38	107	405	10	560	.1
AlA	Amarillo loam, 0 to 1 percent slopes	1,077	378	297	24	1,776	.4
AlB	Amarillo loam, 1 to 2 percent slopes	132	5	535	10	682	.1
AmB	Amarillo loamy fine sand, 0 to 3 percent slopes	14,226	40,842	68,478	3,980	127,526	25.5
An	Arch fine sandy loam	850	1,011	218	55	2,134	.4
Ao	Arch loam	1,050	950	843	76	2,919	.6
AvA	Arvana fine sandy loam, 0 to 1 percent slopes	1,108	3,698	85	105	4,996	1.0
AvB	Arvana fine sandy loam, 1 to 3 percent slopes	92	332	84	14	522	.1
AwA	Arvana fine sandy loam, shallow, 0 to 1 percent slopes	136	630	99	20	885	.2
Be	Berthoud-Potter complex	54	272	1,687	30	2,043	.4
Bp	Bippus and Spur soils	0	254	578	10	842	.2
Br	Brownfield fine sand, thick surface	200	2,487	35,607	270	38,564	7.7
Bs	Brownfield fine sand, thin surface	156	3,573	21,057	144	24,930	5.0
Bt3	Brownfield soils, severely eroded	0	200	1,016	6	1,222	.2
Bv	Brownfield-Tivoli fine sands	0	0	16,414	100	16,514	3.3
DrB	Drake soils, 1 to 3 percent slopes	501	987	551	45	2,084	.4
DrC	Drake soils, 3 to 5 percent slopes	203	434	1,287	40	1,964	.4
DrD	Drake soils, 5 to 8 percent slopes	8	16	227	4	255	.1
Go	Gomez and Portales soils	260	1,943	2,950	150	5,303	1.1
Km	Kimbrough soils	54	90	2,543	60	2,747	.5
Lv	Lubbock clay loam	28	102	33	2	165	(1/)
Lu	Lubbock fine sandy loam	99	124	14	3	240	(1/)
MfA	Mansker fine sandy loam, 0 to 1 percent slopes	325	265	11	20	621	.1
MfB	Mansker fine sandy loam, 1 to 3 percent slopes	280	985	104	50	1,419	.3
MkA	Mansker loam, 0 to 1 percent slopes	104	433	36	15	588	.1
MkB	Mansker loam, 1 to 3 percent slopes	5	115	47	5	172	(1/)
PfA	Portales fine sandy loam, 0 to 1 percent slopes	6,913	13,264	2,337	750	23,264	4.6
PfB	Portales fine sandy loam, 1 to 3 percent slopes	2,053	5,748	2,653	290	10,744	2.1
PmA	Portales loam, 0 to 1 percent slopes	3,200	2,504	1,163	189	7,056	1.4
PmB	Portales loam, 1 to 3 percent slopes	320	130	497	22	969	.2
Ra	Randall soils	234	700	480	35	1,449	.3
Rf	Randall fine sandy loam, thick surface variant	102	306	131	15	554	.1
StA	Stegall loam, 0 to 1 percent slopes	0	119	58	3	180	(1/)
SwA	Stegall loam, shallow, 0 to 1 percent slopes	124	130	192	7	453	.1
Tv	Tivoli fine sand	0	0	19,846	100	19,946	4.0
Tx	Tivoli-Potter complex	95	113	679	15	902	.2
ZfA	Zita fine sandy loam, 0 to 1 percent slopes	3,535	7,655	3,068	410	14,668	2.9
ZfB	Zita fine sandy loam, 1 to 3 percent slopes	256	734	99	35	1,124	.2
ZmA	Zita loam, 0 to 1 percent slopes	1,195	762	536	70	2,563	.5
	Silver Lake	------	------	------	60	60	(1/)
	Total acres	68,800	169,220	250,700	12,400	501,120	100.0
	Total percent	13.7	33.8	50.0	2.5	100.0	

1/ Less than 0.1 percent.

Natural drainage is good. Internal drainage is medium, and permeability is moderate. The water-holding capacity is good in all the Amarillo soils, but the loams hold a little more water than the sandier soils. The loams are high in natural fertility; the sandier soils are less fertile.

Amarillo soils are subject to both wind erosion and water erosion. In many areas wind has blown some of the clay and silt particles from the plow layer, and consequently the layer is more sandy than when first plowed.

Associated with Amarillo soils are Zita, Portales, Mansker, Arvana, Lubbock, and Brownfield soils. Amarillo soils are redder than Zita, Portales, Mansker, and Lubbock soils. They have much more distinct layers than either Portales or Mansker soils. They are less clayey than Lubbock soils and less sandy than Brownfield soils. The caliche layer is soft, rather than hard like that in Arvana soils.

More than 60 percent of the acreage of Cochran County consists of Amarillo soils. Large acreages are in native grass, and other large acreages, both irrigated and dry-farmed, are in cotton and grain sorghum. Winter wheat and rye are grown on small acreages, for grazing as well as for grain.

Amarillo fine sandy loam, 0 to 1 percent slopes (AfA).—This soil occurs in all parts of Cochran County. Most of the areas are large and irregularly shaped. Many are on flats and very gentle slopes just below areas of Amarillo loamy fine sand, 0 to 3 percent slopes.

The surface layer of this soil is about 10 inches thick. The subsoil, about 35 inches thick, is medium sandy clay loam. At a depth of about 30 inches, the soil material is calcareous. The depth to the pink caliche is about 45 inches, and the layer of caliche is about 18 inches thick.

Included with the mapped areas of this soil are small areas of Lubbock, Zita, Portales, Arvana, and Mansker soils. The small bodies of Lubbock and Zita soils, which generally are less than 3 acres in size, appear in the landscape as dark-colored, round, slightly depressed areas. Inclusions of Portales and Mansker soils appear as gray or lighter colored areas, and, unless the field has been leveled, they are likely to be a few inches higher than the surrounding Amarillo soils. If caliche rocks were not scattered on their surface in many places, Arvana soils would be hard to distinguish from the Amarillo. Also included are spots of Amarillo loamy fine sand, which is lighter colored than the fine sandy loam, and areas of Amarillo fine sandy loam, 1 to 3 percent slopes, as much as 6 or 8 acres in size.

Large acreages of this soil are used as range, and other large acreages are farmed. The water erosion hazard is slight, but there is a moderate hazard of wind erosion. (Nonirrigated capability unit IIIe-1; irrigated capability unit IIe-2; Mixed Land range site.)

Amarillo fine sandy loam, 1 to 3 percent slopes (AfB).—This soil occurs on ridges within larger bodies of Amarillo fine sandy loam, 0 to 1 percent slopes, and also on slopes around small playas.

The surface layer of this soil is about 8 inches thick. The subsoil is about 30 inches thick and is slightly redder than that of Amarillo fine sandy loam, 0 to 1 percent slopes.

Included in the areas mapped are a few small areas of Amarillo fine sandy loam, 3 to 5 percent slopes, of Amarillo fine sandy loam, 0 to 1 percent slopes, and of Portales, Arvana, and Mansker soils.

Large acreages of this soil are cultivated. Many cultivated areas are irrigated, most of them by means of sprinklers. Cotton and grain sorghum are the main crops. Surface runoff is greater than on Amarillo fine sandy loam, 0 to 1 percent slopes. The hazards of sheet and gully erosion and wind erosion are moderate. (Nonirrigated capability unit IIIe-1; irrigated capability unit IIIe-2; Mixed Land range site.)

Amarillo fine sandy loam, 3 to 5 percent slopes (AfC).—This soil occurs mainly on the northwest slopes of playas, within larger areas of Amarillo fine sandy loam, 1 to 3 percent slopes. The individual areas are 5 to 30 acres in size, and the total acreage is small.

The surface layer of this soil is about 6 inches thick, and the subsoil is about 25 inches thick. These layers are slightly redder than corresponding layers in Amarillo fine sandy loam, 1 to 3 percent slopes.

Included in the areas mapped are a few small spots of Mansker soil and of Amarillo fine sandy loam, 1 to 3 percent slopes.

Most of this soil is used as range, the use to which it is best suited. Runoff is greater than on the other Amarillo soils. There is a serious hazard of sheet and gully erosion and a moderate hazard of wind erosion. (Nonirrigated capability unit IVe-1; irrigated capability unit IVe-1; Mixed Land range site.)

Amarillo loam, 0 to 1 percent slopes (AlA).—This soil occurs in the northern part of the county, on the smoother, lower flats and on very gentle slopes within areas of Amarillo fine sandy loam, 0 to 1 percent slopes. The total acreage is small.

The surface layer of this soil is about 8 inches thick. The subsoil, about 30 inches thick, is sandy clay loam or light clay loam. The lower part of the subsoil is less clayey than the upper part and contains more free lime. The depth to the layer of pink caliche is about 38 inches, and this layer is about 20 inches thick.

Included in the areas mapped are a few small spots of Portales loam and Mansker loam, and also some small areas of Amarillo fine sandy loam, 0 to 1 percent slopes.

This soil is high in fertility and in water-holding capacity, but inadequate rainfall limits yields of dry-farmed crops. There is only a slight hazard of either wind or water erosion. Most areas are irrigated. Cotton and grain sorghum are the main crops. (Nonirrigated capability unit IIIce-1; irrigated capability unit IIe-1; Deep Hardland range site.)

Amarillo loam, 1 to 2 percent slopes (AlB).—This soil occurs mainly on slopes around playas, within larger areas of Amarillo loam, 0 to 1 percent slopes. Some areas are between ridges of Kimbrough soils in the northeastern part of the county. The total acreage is small.

The surface layer is about 7 inches thick. The subsoil is a little thinner than that of Amarillo loam, 0 to 1 percent slopes, and it may be slightly redder. The layer of caliche is about 30 to 35 inches below the surface. In places this caliche is slightly hard.

Most areas of this soil are in native grass. A few small areas are irrigated. Surface runoff is more rapid than on Amarillo loam, 0 to 1 percent slopes. The hazard of wind

erosion is slight. (Nonirrigated capability unit IIIe–2; irrigated capability unit IIIe–1; Deep Hardland range site.)

Amarillo loamy fine sand, 0 to 3 percent slopes (AmB).—This nearly level to gently undulating or rolling soil occurs throughout the county but is most common in the central part. It is lower, smoother, and less undulating than Brownfield fine sand, but higher and more rolling than Amarillo fine sandy loam. The areas are very large and are irregular in shape. Generally, the slope is less than 2 percent.

The surface layer of this soil is about 12 inches thick. It is a little thicker in places where deep plowing has brought up some of the subsoil, but it is generally less than 16 inches thick. It is less red than the surface layer of Amarillo fine sandy loam. The subsoil, about 35 to 45 inches thick, is thicker than that of other Amarillo soils and may also be less clayey. Below a depth of 30 inches, the subsoil is commonly redder and less limy than that of Amarillo fine sandy loam. The depth to the layer of pink caliche ranges from 48 to 60 inches, and this layer is about 15 inches thick.

Included in the areas mapped are small areas that have slopes of more than 3 percent; other areas that have sustained moderately severe damage from wind erosion; patches less than 5 acres in size of Gomez and Portales soils and of Amarillo fine sandy loam; and a few areas, ranging up to 15 acres in size, of a soil that has an 8- to 16-inch surface layer of dark-brown loamy fine sand but otherwise is similar to Zita fine sandy loam.

Large acreages of this soil, both irrigated and nonirrigated, are farmed. Even larger acreages are used as range. Surface runoff is slight, but the soil is highly susceptible to wind erosion. During the windy season small dunes form in some fields. During the cropping season the dunes are smoothed out, but each time the surface layer is more sandy than before. Many farmers deep plow this soil to increase the clay content of the surface layer and make it more resistant to wind erosion. (Nonirrigated capability unit IVe–2; irrigated capability unit IIIe–5; Sandy Land range site.)

Arch Series

The Arch series consists of shallow, friable, light-colored, limy, nearly level soils that occur in old stream valleys and in playas.

The surface layer of Arch soils is light brownish gray or light gray. It ranges from 4 to 8 inches in thickness and from fine sandy loam to loam in texture. The subsoil is light gray. It is 6 to 14 inches thick. Both the surface layer and the subsoil are high in content of lime, both have a weak granular structure, and both contain small fragments of caliche.

The parent material consists of a thick bed of friable, limy, old alluvium, or plains outwash, the upper part of which apparently was enriched with lime deposited from ground water.

Internal drainage is rapid, and permeability is moderately rapid. Runoff is very slow. The water-holding capacity is low. Natural fertility is low to moderate.

Because of their high content of lime, Arch soils are unstable and are highly susceptible to wind erosion. In many areas, wind has blown some of the silt and clay particles from the surface layer, and consequently the uppermost 3 to 6 inches of the surface layer is coarser textured now than when first plowed.

Arch soils are lighter colored and higher in lime than the closely associated Portales soils, and they have a thinner surface layer. They are more nearly level than the Drake soils, and they are more limy and lighter colored than the Mansker soils.

Most of the acreage of Arch soils in Cochran County is cultivated, and about half the cultivated acreage is irrigated. Nevertheless, these soils are better suited to range than to cultivated crops. They are poorly suited to cotton unless irrigated, and yields of cotton are only moderate, even under irrigation. Grain sorghum and small grain can be grown, but yields are low.

The large amount of lime in the soil restricts the availability of plant nutrients and often causes chlorosis in grain sorghum.

Arch fine sandy loam (An).—This soil occurs mainly in the northern part of the county. Most of it is level, but small areas have a slope of 1 or 2 percent.

The surface layer of this soil is about 6 inches thick. The subsoil consists of loam or light sandy clay loam and is about 9 inches thick.

Included with the mapped areas of this soil are small spots of Portales fine sandy loam, 0 to 1 percent slopes; small spots of Mansker and Zita soils; small, level areas of Arch loam; and areas of Drake soils, 1 to 3 percent slopes. The Drake soils appear in the landscape as light-gray knolls, 1 or 2 feet high and less than 1 acre in size. In many cultivated fields, these knolls have been leveled.

Although this soil is highly susceptible to wind erosion, most of it is cultivated, and nearly half of it is irrigated. Grain sorghum is the main crop. Cotton and small grain are grown also. (Nonirrigated capability unit IVes–1; irrigated capability unit IIIes–1; High Lime range site.)

Arch loam (Ao).—This soil occurs mainly in the northern part of the county, as one large area and a few small, scattered areas. Most of it is level, but small areas are included that have a slope of 1 or 2 percent.

The surface layer of this soil is about 6 inches thick. The subsoil consists of loam or light clay loam and is about 9 inches thick.

Included in the mapped areas are small areas of Portales loam, 0 to 1 percent slopes (fig. 7), and of Drake, Mansker, and Zita soils.

Most of the acreage is cultivated, and more than half is irrigated. Grain sorghum is the main crop. Cotton and small grain are also grown. The hazard of wind erosion is a little less severe than on Arch fine sandy loam. (Nonirrigated capability unit IVes–1; irrigated capability unit IIIes–1; High Lime range site.)

Arvana Series

The Arvana series consists of shallow to moderately deep, friable, dark-colored, neutral to mildly alkaline, nearly level to gently sloping soils on uplands. These soils are underlain by hard, platy caliche.

The surface layer of Arvana soils ranges from fine sandy loam to light loam in texture, from reddish brown to brown in color, and from 6 to 10 inches in thickness. This layer is free of lime and is easy to work. It has a

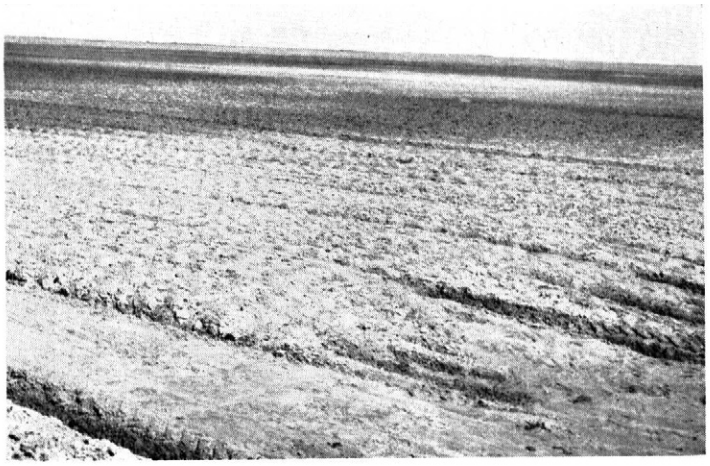

Figure 7.—**Inclusions of Portales soils in areas of Arch soils. The light-colored areas are Arch, and the dark-colored areas are Portales.**

weak granular structure unless plowing has destroyed the structure.

The subsoil ranges from 10 to 24 inches in thickness. It contains more clay than the surface layer; the texture is light sandy clay loam or medium sandy clay loam. The upper part of the subsoil is reddish brown and has a moderate, coarse, prismatic structure. The lower part is less clayey than the upper part, and it contains free lime. It is yellowish red or red and has a weak, coarse, prismatic structure.

The parent material consists of a thin mantle of moderately sandy, friable, calcareous, wind-worked sediments deposited over a thick bed of hard caliche. The depth to the hard caliche is 10 to 36 inches. The layer of hard caliche is 1 to 2 feet thick. Below it are thick beds of softer, massive caliche.

Drainage is good. Internal drainage is medium, and permeability is moderate. The water-holding capacity is low to moderate. Natural fertility is low to moderately high. The hazard of wind erosion is moderate. In places, there is some hazard of water erosion.

Arvana soils are shallower than the associated Amarillo soils, and the caliche layer is hard, rather than soft like that in the Amarillo soils. Arvana soils are more sandy than Stegall soils and much deeper than Kimbrough soils; both Stegall and Kimbrough soils have a layer of hard caliche.

Most of the acreage of Arvana soils in Cochran County is cultivated. Grain sorghum and small grain are suitable crops. Cotton can be grown on the deeper soils of the series. Native grass is the best crop for the shallow soils, but grain sorghum is grown on most areas. Under irrigation, some cotton can be grown on the shallow soils.

Arvana fine sandy loam, 0 to 1 percent slopes (AvA).—This soil occurs mainly in the northern part of the county, on broad, smooth uplands. Generally, its position in the landscape is about the same as that of Amarillo fine sandy loam, 0 to 1 percent slopes, but some areas are slightly downslope from areas of the very shallow Kimbrough soils.

The surface layer of this soil is about 8 inches thick. The subsoil consists of medium sandy clay loam and is about 22 inches thick.

Included on the map are spots of very rocky Kimbrough soils; of shallow Arvana soils that may have caliche rocks on the surface; of Amarillo fine sandy loam, 0 to 1 percent slopes; and of Arvana fine sandy loam, 1 to 3 percent slopes.

Most of the acreage is cultivated, and many areas are irrigated. The amount of runoff is small. In some areas that have been damaged by wind erosion, the surface layer is more sandy than when it was first plowed. (Nonirrigated capability unit IIIe–1; irrigated capability unit IIe–2; Mixed Land range site.)

Arvana fine sandy loam, 1 to 3 percent slopes (AvB).—This soil occurs on ridges or slopes around playas, mainly within large areas of Arvana fine sandy loam, 0 to 1 percent slopes. The total acreage is small.

The surface layer of this soil is about 7 inches thick. The subsoil is about 20 inches thick and may be slightly redder than that of Arvana fine sandy loam, 0 to 1 percent slopes.

Included on the map are small areas of Kimbrough soils, of Arvana fine sandy loam, 0 to 1 percent slopes, of Arvana fine sandy loam, shallow, 0 to 1 percent slopes, and of Amarillo fine sandy loam, 1 to 3 percent slopes.

Most of the acreage is dry farmed. Grain sorghum is the main crop. The hazards of sheet, gully, and wind erosion are moderate. (Nonirrigated capability unit IIIe–1; irrigated capability unit IIIe–2; Mixed Land range site.)

Arvana fine sandy loam, shallow, 0 to 1 percent slopes (AwA).—This soil occurs in the northern part of the county. Most of it is nearly level, but the slope ranges up to 2 percent. The areas are small and scattered, and the total acreage is small. Many areas are between deeper Arvana soils and very shallow Kimbrough soils.

The surface layer of this soil is about 6 inches thick. The subsoil consists of reddish-brown sandy clay loam and is about 10 inches thick. The depth to the hard caliche is only about 20 inches. Caliche rocks are scattered on the surface.

Included in the mapped areas of this soil are a few small areas of Kimbrough soils and pockets of deeper Arvana soils.

This soil is of limited use because it is so shallow. It is best suited to native grass, but most areas are cultivated because they are located within larger areas of deeper soils. The caliche layer near the surface makes terracing and leveling difficult, and the rocks on the surface interfere with tillage. The water-holding capacity is low. (Nonirrigated capability unit IVe–4; irrigated capability unit IIIe–7; Mixed Land range site.)

Berthoud Series

The Berthoud series consists of shallow and moderately deep, light-colored, friable soils that are limy throughout.

The surface layer of Berthoud soils ranges from 6 to 15 inches in thickness, from fine sandy loam to light sandy clay loam in texture, and from brown to grayish brown in color. The structure is weak granular or weak coarse prismatic.

The subsoil is light sandy clay loam or medium sandy clay loam. It ranges from 6 to 15 inches in thickness and from brown to pale brown in color. The surface layer

and subsoil are thinnest where the slope is strongest. Below the subsoil is a faint, but evident, light-brown to very pale brown, calcium carbonate layer that ranges from only a few inches to about 30 inches in thickness.

The parent material is friable, calcareous, loamy colluvium. It could be penetrated easily by roots, but it seldom contains enough moisture for plants. In places, a buried soil occurs at a depth of 4 to 5 feet.

Internal drainage is medium, and permeability is moderately rapid. Runoff is rapid. The water-holding capacity is moderate, but the lower layers are seldom wet. Natural fertility is moderate. The hazards of wind erosion and water erosion are moderate.

Berthoud soils occur on slopes above areas of Bippus soils and below areas of Potter and Mansker soils. They are lighter colored than Bippus soils and deeper than either Potter or Mansker soils.

The Berthoud soils occur mainly on short slopes along Sulphur Draw, in the southeastern part of the county. Most of the acreage is used as range.

Berthoud-Potter complex (Be).—This complex occurs mainly on short slopes along Sulphur Draw, in the southeastern part of the county. It consists of Berthoud, Mansker, and Potter soils, each occurring in such narrow bands along the slopes that it is not practical to show them separately on the soil map. Any one area is about 40 percent Berthoud soils, about 35 percent Mansker soils, and about 25 percent Potter soils.

Berthoud soils are on the lowest part of the slopes. The slope range is 3 to 8 percent.

Mansker soils are slightly higher up on the slopes than Berthoud and Potter soils. The slope range is 3 to 5 percent. In this complex the Mansker soils are lighter colored, steeper, and shallower than the typical Mansker soils described under the heading "Mansker Series." The surface layer of brown or grayish-brown fine sandy loam is 5 to 8 inches thick. The subsoil of pale-brown light sandy clay loam or loam is 6 to 10 inches thick. Under the subsoil is soft caliche that contains many small pebbles of hard caliche.

Potter soils are on the steepest part of the slopes. The slope range is 1 to 12 percent, but the slope is generally less than 8 percent. In places the underlying caliche crops out. The Potter soils in this complex are like those described under the heading "Potter Series."

In most places these soils have a gravelly appearance because of the many small concretions of calcium carbonate on the surface and in the soil.

Also included in mapped areas of this complex are small spots of Bippus and Amarillo soils and small eroded areas in which the gullies are 3 to 6 feet wide and as much as 4 feet deep.

Most of the acreage is in native grass. Use is limited by steep slopes, shallowness, and the hazard of erosion. (Capability unit VIe–3; Berthoud and Mansker soils are in the Mixed Plains range site; Potter soils are in the Shallow Land range site.)

Bippus Series

The Bippus series consists of deep, friable, dark-colored, nearly level to gently sloping soils.

The surface layer of Bippus soils ranges from 15 to 40 inches in thickness and from dark brown to very dark grayish brown in color. This layer is free of lime. Its upper part ranges from fine sandy loam to light clay loam, and its lower part from light sandy clay loam to clay loam. The upper part has a weak granular structure; the lower part, below a depth of 8 inches, has a moderate, medium or coarse, subangular blocky structure that breaks to weak granular.

The subsoil ranges from 6 to 30 inches in thickness, from light sandy clay loam to clay loam in texture, and from brown or grayish brown to light grayish brown in color. The surface layer and subsoil are thinnest where the slope is strongest.

The parent material is limy, friable, loamy alluvium washed from nearby uplands.

Natural drainage is good. Internal drainage is medium, and permeability is moderate. The water-holding capacity is good. Natural fertility is high. The hazards of wind erosion and water erosion are slight.

Bippus soils are darker colored and more deeply leached of lime than the closely associated Spur soils. They are much darker colored, less strongly sloping, and more deeply leached of lime than Berthoud soils.

The Bippus soils occur mainly along Sulphur Draw, in the southeastern part of the county. They are not mapped separately but are included in an undifferentiated group with Spur soils. Most of the acreage is in native grass, but the soils are suited to crops, and a small acreage is cultivated. Grain sorghum is the main crop.

Bippus and Spur soils (Bp).—These soils occur mainly in the bottom of Sulphur Draw, a shallow, narrow draw in the southeastern part of the county. About 80 percent of the areas consist of Bippus soils, which occur where the bottom of the draw is less than 150 feet wide and which have a slope of as much as 1½ percent. About 20 percent of the areas consist of Spur soils, which occur in the few places where the draw is wider and which have a slope of less than half of 1 percent. Also included in the unit are a few small areas of Berthoud soils and minor areas of recently deposited material washed from nearby slopes.

The surface layer of Bippus soils is about 30 inches thick, and that of Spur soils is about 15 inches thick. Bippus soils are not calcareous, but Spur soils are calcareous. Bippus soils are dark grayish brown, and Spur soils are dark brown. The two kinds of soil have similar subsoil.

Most of the acreage is included in large ranches and is used as range, although the soils are well suited to most of the crops grown in the county. Sulphur Draw seldom carries runoff water, so the soils are seldom overflowed. The small amount of extra water that runs down the side slopes does not ordinarily exceed the storage capacity of the soils, and it helps to increase yields. (Nonirrigated capability unit IIIe–1; irrigated capability unit IIe–2. Bippus soils are in the Mixed Land range site; Spur soils are in the Mixed Plains range site.)

Brownfield Series

The Brownfield series consists of deep, loose, light-colored, neutral, sandy soils.

The surface layer of Brownfield soils is light-brown or brown, loose fine sand. The upper part is a little darker colored than the lower. This layer is 10 to 36 inches

thick. The areas where it is less than 18 inches thick are mapped as a thin-surface phase.

The subsoil ranges from light sandy clay loam to light sandy clay in texture, from red or reddish brown to yellowish red in color, and from 30 to 60 inches in thickness. This layer is friable, and it has a moderate, coarse, prismatic structure that breaks to subangular blocky. The lower part is less clayey than the upper part.

The parent material consists of friable, windblown, sandy earths that are weakly calcareous in places and that range in texture from light sandy clay loam to loamy fine sand.

Old soils buried beneath the Brownfield soils range from clay loam to sandy clay in texture. In places there is a buried layer of caliche.

Internal drainage is rapid, and permeability is moderate to moderately rapid. Runoff is very slow. The water-holding capacity is low to moderate. Natural fertility is medium. These soils are highly susceptible to wind erosion. In cultivated areas, fence-row dunes as much as 10 feet high are common.

Brownfield soils are more undulating than Amarillo soils, and they have a thicker, lighter colored, more sandy surface soil and a redder subsoil. They have a more clayey subsoil than Tivoli fine sand.

Brownfield soils occur as broad, undulating areas in the southern and western parts of Cochran County. Most of the acreage is in native grass. Grain sorghum is the chief cultivated crop. Some areas once cultivated have been abandoned because of wind erosion.

Brownfield fine sand, thick surface (Br).—This soil occurs as broad, undulating areas in the southern and western parts of the county. The slope range is 0 to 3 percent.

The surface layer of this soil is about 24 inches deep. The surface is characterized by mounds or dunes 1 to 3 feet high and 10 to 20 feet in diameter. The subsoil consists of sandy clay loam and is about 35 inches thick.

Included on the map are areas of Tivoli fine sand less than 2 acres in size; small areas of Brownfield fine sand, thin surface; and small areas of severely eroded Brownfield soils.

Nearly all of the acreage is in native grass. Cultivated areas are moderately eroded. Deep plowing does not help to control erosion, because in most places the sand is so thick that the clayey subsoil cannot be reached with the plow. (Nonirrigated capability unit VIe–2; irrigated capability unit IVe–3; Deep Sand range site.)

Brownfield fine sand, thin surface (Bs).—This soil occurs as zones of transition between Brownfield fine sand, thick surface, and Amarillo loamy fine sand, 0 to 3 percent slopes. It is less undulating than the thick-surfaced Brownfield soil and more so than the Amarillo soil. The slope range is 0 to 3 percent.

The surface layer of this soil is about 14 inches thick. The subsoil consists of sandy clay loam and is about 40 inches thick.

Included in the areas mapped are small areas of Brownfield fine sand, thick surface; of Amarillo loamy fine sand, 0 to 3 percent slopes; of eroded Brownfield soils; and of Gomez and Portales soils.

Most of the acreage is used as range, but some large areas are dry farmed. Deep plowing helps to control wind erosion in most areas. (Nonirrigated capability unit IVe–3; irrigated capability unit IIIe–6; Sandy Land range site.)

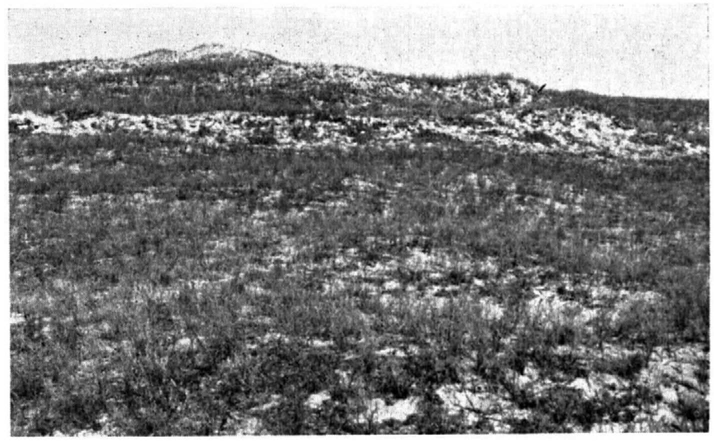

Figure 8.—**Brownfield-Tivoli fine sands. Brownfield fine sand, thick surface, in foreground; dune of Tivoli fine sand in background.**

Brownfield soils, severely eroded (Bt3).—These soils occur mainly in the southwestern part of the county. The areas are 50 to 100 acres in size. The slope is generally less than 3 percent.

Wind erosion has removed more than half of the original surface layer. In places all of it is gone. In many places the loose sand of the surface layer has been blown into hummocks or dunes 2 to 6 feet high. As a result, the surface has a choppy appearance and the subsoil is exposed in many places. Fence-row dunes 6 to 10 feet high and 100 to 200 feet wide have formed along the east side of most eroded fields.

Most of the acreage has been cultivated and then abandoned. Much of it has been reseeded to grass. (Capability unit VIe–2; Deep Sand range site.)

Brownfield-Tivoli fine sands (Bv).—This complex consists of areas in the southern and western parts of the county in which Brownfield fine sand, thick surface, and Tivoli fine sand are so intermixed that it is not practical to map them separately. Between 60 and 75 percent of the acreage consists of the Brownfield soil, and between 25 and 40 percent consists of the Tivoli soil. Also included in the mapping unit are a few small areas of Gomez and Portales soils.

The Brownfield soil is undulating and rolling. The Tivoli soil consists of dunes 7 to 15 feet high and 1 or 2 acres in size. The dunes are surrounded by and intermingled with Brownfield fine sand (fig. 8). Ordinarily, several dunes are connected.

The soils in this complex are not suited to cultivation, because they are very susceptible to wind erosion. They are well suited to range. (Capability unit VIIe–1; Deep Sand range site.)

Drake Series

The Drake series consists of shallow, light-colored, limy, gently sloping and sloping, strongly calcareous soils. These soils occur east and southeast of playas, as crescent-shaped or oblong dunes 10 to 50 acres in size and 6 to more than 30 feet high.

The surface layer of Drake soils is 4 to 12 inches thick. It is thinnest on the crests of the dunes. In texture this layer ranges from loam to loamy fine sand but is most commonly fine sandy loam. In color it ranges from grayish brown to light gray. It is friable and very limy and has a weak granular structure.

The subsoil is 5 to 15 inches thick and consists of pale-brown to light-gray, very limy loam. It has a weak granular structure.

The parent material consists of friable, very limy, wind-deposited material blown from the playas.

Internal drainage is rapid, and permeability is moderately rapid. The water-holding capacity is low. Natural fertility is low. These soils are readily eroded by either wind or water. Their lime content makes them unstable, and they are on the highest part of the landscape where they get the full force of the wind.

Drake soils are lighter colored and more limy than Portales soils, and they have less distinct layers. They lack the distinct layer of caliche that is characteristic of the nearly level Arch soils.

About half the acreage of Drake soils in Cochran County is cultivated, and some areas are irrigated. These soils are best suited to native grass. They are poor for cotton but, if irrigated and carefully managed, may produce moderate yields of grain sorghum or small grain. The lime tends to prevent some plants from obtaining nutrients, especially iron, from the soil.

Drake soils, 1 to 3 percent slopes (DrB).—These soils occur as small, low dunes east of playas. The areas are small and scattered. Some are on the lower slopes of much larger and steeper dunes.

The surface layer of these soils consists of fine sandy loam or loam and is about 8 inches thick. The subsoil consists of loam and is about 10 inches thick.

Included in the mapping are small areas of Drake soils, 3 to 5 percent slopes, and of Portales fine sandy loam, 1 to 3 percent slopes.

Most of the acreage is used to grow grain sorghum, but the large amount of lime in the soil often causes chlorosis of sorghum plants. Wind erosion is a serious hazard. The amount of surface runoff is less than on Drake soils, 3 to 5 percent slopes. (Nonirrigated capability unit IVes–1; irrigated capability unit IIIes–1; High Lime range site.)

Drake soils, 3 to 5 percent slopes (DrC).—These soils occur as small, low dunes east of playas. Some areas are on the lower slopes of much larger and steeper dunes.

The surface layer of these soils consists of loam, fine sandy loam, or, less commonly, loamy fine sand. It is about 6 inches thick. The subsoil consists of loam and is about 7 inches thick.

Included in the areas mapped are a few small areas of Drake soils, 1 to 3 percent slopes, and of Drake soils, 5 to 8 percent slopes.

These soils are unsuited to dryland farming and are of very limited use if irrigated. Wind erosion is a hazard on cultivated areas, and because of the steeper slopes, water erosion is a more serious hazard than on Drake soils, 1 to 3 percent slopes. Most of the acreage is in blue grama and other native grass. (Nonirrigated capability unit VIe–1; irrigated capability unit IVe–2; High Lime range site.)

Drake soils, 5 to 8 percent slopes (DrD).—These soils occur as high, steep dunes east and southeast of playas. The areas are small and scattered, and the total acreage is small.

The surface layer of these soils consists of fine sandy loam, loamy fine sand, or loam, and is about 4 inches thick. The subsoil, about 6 inches thick, consists of loam or heavy fine sandy loam.

Included in the areas mapped are small areas of Drake soils, 3 to 5 percent slopes.

These soils are unsuited to cultivated crops. Nearly all the acreage is in native grass. The hazards of wind erosion and water erosion are severe. (Capability unit VIe–1; High Lime range site.)

Gomez Series

The Gomez series consists of moderately deep, very friable, light-colored, sandy soils that occur in slight depressions and in old, shallow drainageways.

The surface layer of Gomez soils ranges from 10 to 30 inches in thickness, from fine sand to loamy fine sand in texture, and from grayish brown to brown or pale brown in color. It is single grain or has a very weak granular structure. In places it is calcareous.

The subsoil ranges from 8 to 20 inches in thickness, from heavy loamy fine sand to light fine sandy loam in texture, and from pale brown to light brownish gray in color. This layer is calcareous. Below the subsoil is a 10- to 25-inch layer that has a fine sandy loam texture but is 20 to 50 percent calcium carbonate.

The parent material consists of calcareous, sandy sediments that appear to have been affected by a high water table at some time in the past.

Internal drainage is rapid, and permeability is moderately rapid. There is no runoff. The water-holding capacity is low to moderate. Natural fertility is low to moderate. These soils are highly susceptible to wind erosion.

Gomez soils are lighter colored and more sandy than Portales soils. They are deeper and more sandy than Arch soils. They have a more sandy and less red subsoil than Brownfield soils.

Gomez soils occur mainly in the southern part of Cochran County, generally within large areas of Brownfield soils. They are unsuitable for cultivation because they are highly erodible. Most of the acreage is in native grass.

Gomez and Portales soils (Go).—This unit consists of Gomez fine sand and loamy fine sand and Portales loamy fine sand, which are mapped together because they are much alike in many characteristics and have similar management requirements. The Gomez soils occur in the southern part of the county, within large areas of Brownfield fine sand. The Portales soil occurs mainly in the central part of the county, within large areas of Amarillo loamy fine sand. Both kinds of soil are common in the vicinity of Lehman and of Bledsoe.

The Gomez soils in this unit have a 10- to 30-inch surface layer of brown fine sand or loamy fine sand, and an 8- to 20-inch subsoil of pale-brown fine sandy loam. Under the subsoil is a layer of whitish, sandy caliche.

The Portales soil has a 10- to 24-inch surface layer of loamy fine sand, and a 15- to 30-inch subsoil of pale-brown sandy clay loam. Under the subsoil is a thick layer of soft, whitish, loamy caliche. This is an overblown phase of

Portales fine sandy loam, which is described under the heading "Portales Series." In many places there is a layer of fine sandy loam between the surface layer and the subsoil. The sandy surface layer consists of material blown from surrounding cultivated areas of Amarillo loamy fine sand.

Also included in this mapping unit are spots of Portales fine sandy loam, 0 to 1 percent slopes; small areas that are wind eroded; and small areas of a soil that is similar to Zita fine sandy loam except that it has about 15 inches of overblown loamy fine sand on the surface.

These soils are poorly suited to cultivation because of low fertility, low moisture-holding capacity, and a serious hazard of wind erosion. Nevertheless, some areas are cultivated because they are within areas of cultivated Amarillo soils. Grain sorghum is the main crop. The areas that are within areas of Brownfield soils are used as range. They are well suited to mid and tall grasses. Some areas have been cultivated and then abandoned. (Nonirrigated capability unit IVe–2; irrigated capability unit IVe–3; Sandy Land range site.)

Kimbrough Series

The Kimbrough series consists of very shallow, dark-colored, mildly alkaline, nearly level to moderately sloping soils that are underlain by thick beds of rocklike caliche.

The surface layer of Kimbrough soils ranges from fine sandy loam to loam in texture, from brown to dark grayish brown in color, and from 2 to 10 inches in thickness. The structure is granular. This layer rests directly on the hard caliche, and there are many small outcrops of the caliche.

Internal drainage is rapid, and runoff is slow. Permeability is moderately rapid. The water-holding capacity is low. Natural fertility is low to medium. The soils are susceptible to both wind erosion and water erosion. Kimbrough soils are darker colored and more deeply leached of lime than Potter soils, and they are underlain by harder caliche. They are less deep and less red than Arvana soils, and less deep and less clayey than Stegall soils.

Kimbrough soils occur in the northern part of Cochran County. They are not suited to cultivation and are used mostly as range.

Kimbrough soils (Km).—These soils occur on low hills or ridges, between which are areas of the deeper Stegall, Arvana, and Amarillo soils. Small areas are scattered through the northern part of the county. In the northeastern part are some fairly large areas. The slope is generally less than 2 percent but ranges up to 5 percent.

Included in the areas mapped are a few small areas of Arvana fine sandy loam, shallow, 0 to 1 percent slopes, and of Stegall loam, shallow, 0 to 1 percent slopes.

These soils are slightly eroded. Nearly all of the acreage is in native grass. (Capability unit VIIs–1; Shallow Land range site.)

Lubbock Series

The Lubbock series consists of deep, dark-colored, level soils that occur in slight depressions.

The surface layer of Lubbock soils ranges from fine sandy loam to clay loam in texture and from 8 to 14 inches in thickness. The color is dark brown or dark grayish brown. The reaction is neutral to mildly alkaline. The upper part, unless it has been plowed, has a granular structure. The structure below the normal plow depth is weak coarse prismatic but breaks to granular.

The subsoil is 24 to 40 inches thick and consists of three layers. The uppermost of the three layers is less than 12 inches thick. It consists of very dark grayish-brown clay loam that has a moderate, medium, subangular blocky structure. The middle layer is 8 to 20 inches thick. It consists of gray, compact, light clay or heavy clay loam that has a moderate, fine, blocky structure. The reaction is neutral or mildly alkaline. The lowest layer consists of clay loam and is less than 8 inches thick. It is lighter gray than the upper layers, and it contains free lime. The structure is weak subangular blocky.

The parent material consists of friable, calcareous, clay loam sediments.

Drainage is moderately good. Internal drainage is slow, and there is no runoff. Permeability is slow. These soils have very good water-holding capacity. They receive some runoff from surrounding soils but seldom an amount that exceeds their storage capacity. They are high in natural fertility but are susceptible to wind erosion and are droughty unless irrigated.

Lubbock soils are darker colored than Amarillo and Zita soils, and they have more clay in the subsoil. They have more distinct layers than the Randall soils but are less clayey.

Most of the acreage is cultivated, and a little is irrigated. Cotton, grain sorghum, and other crops can be grown, as well as native grass.

Lubbock clay loam (Lv).—This soil occurs in slight depressions, mainly in the northern part of the county. It is surrounded by slightly higher areas of Amarillo and Zita soils. Water that runs off these higher soils seldom damages crops in the depressions and may, in fact, be beneficial because Lubbock clay loam is droughty unless irrigated. However, sandy soil material washed from the higher areas may impair the productivity of the Lubbock soil.

The surface layer of this soil is about 10 inches thick. The subsoil consists of light clay or heavy clay loam and is about 30 inches thick. Below the subsoil is a layer of soft, light-gray caliche.

Included in the areas mapped are a few spots of Zita loam, 0 to 1 percent slopes; of Randall soils; and of Lubbock fine sandy loam.

Most of this soil is cultivated. The hazard of wind erosion is slight. (Nonirrigated capability unit IIIce–1; irrigated capability unit IIe–1; Deep Hardland range site.)

Lubbock fine sandy loam (Lu).—This soil occurs in slight depressions, mainly in the northern part of the county. It is surrounded by slightly higher areas of Amarillo and Zita soils. The individual areas are a little larger than those of Lubbock clay loam, and the depressions are somewhat shallower than those in which the clay loam occurs. Like Lubbock clay loam, this soil receives from the surrounding higher areas runoff water, which is beneficial, and sandy material, which may be damaging.

The surface layer of this soil is about 10 inches thick. The subsoil is about like that of Lubbock clay loam. Be-

low the subsoil is a layer of soft, white or gray caliche.

Included in the areas mapped are a few spots of Zita fine sandy loam, 0 to 1 percent slopes; of Lubbock clay loam; of Randall soils; and of Amarillo fine sandy loam, 0 to 1 percent slopes.

This soil is less droughty than Lubbock clay loam and, consequently, more productive when dry farmed. Most of the acreage is cultivated. (Nonirrigated capability unit IIIe-1; irrigated capability unit IIe-2; Mixed Land range site.)

Mansker Series

The Mansker series consists of friable, dark-colored, shallow, calcareous, nearly level to moderately sloping soils on uplands.

The limy surface layer of Mansker soils ranges from fine sandy loam to loam in texture and from 6 to 10 inches in thickness. The color is brown or grayish brown. The structure is granular, unless the natural structure has been destroyed by plowing. Caliche gravel is common on the surface and throughout the profile.

The subsoil is more limy than the surface layer. It consists of light sandy clay loam or clay loam. It ranges from 6 to 12 inches in thickness and from pale brown to grayish brown in color. The structure is weak coarse prismatic or granular.

The parent material consists of friable plains sediments that contain free lime and many concretions of calcium carbonate.

Drainage is good. Internal drainage is rapid, and permeability is moderately rapid. The water-holding capacity is low. Natural fertility is low to moderate. These soils are susceptible to wind erosion and, in the more strongly sloping areas, to water erosion also.

Mansker soils have thinner layers and are less deep than Portales and Berthoud soils. They are darker colored and less limy than Arch soils. They are grayer than Amarillo and Arvana soils and have much thinner layers. They are darker colored than Potter soils and have thicker layers.

Mansker soils occur in the northern part of Cochran County, as many small areas within areas of deeper soils. They are better suited to grass than to cultivated crops because they are droughty and erodible. Most of the acreage, nevertheless, is cultivated, along with the associated deeper soils. Cotton and grain sorghum are the main crops. Yields are low compared to yields obtained on deeper soils. A few areas are irrigated, but frequent watering is required to supply enough moisture for crops. The lime in the soil restricts the availability of plant nutrients and often causes chlorosis in grain sorghum.

Mansker fine sandy loam, 0 to 1 percent slopes (MfA).—This soil occurs as small scattered areas within large areas of Portales fine sandy loam or Amarillo fine sandy loam.

The surface layer of this soil is about 7 inches thick. In many areas, this layer is coarser textured now than when it was first cultivated because the wind has removed some of the clay and silt particles from the plow layer. The subsoil consists of light sandy clay loam or light clay loam and is about 9 inches thick. Below the subsoil, at a depth of about 16 inches, is a thick layer of caliche that is cemented in some places.

Included in the mapped areas are spots of Potter soils, which are less than 10 inches deep over caliche. Also included are small areas of Portales fine sandy loam, 0 to 1 percent slopes, and of Mansker fine sandy loam, 1 to 3 percent slopes.

Most of the acreage is cultivated, and more than half is irrigated. The hazard of wind erosion is moderate. (Nonirrigated capability unit IVe-4; irrigated capability unit IIIe-7; Mixed Plains range site.)

Mansker fine sandy loam, 1 to 3 percent slopes (MfB).—This soil occurs as small, scattered areas on knolls and small ridges and on slopes around playas, within large areas of Portales fine sandy loam and Amarillo fine sandy loam. It also occurs on slope breaks along draws, below areas of Amarillo soils and above areas of Berthoud and Potter soils.

This soil is very slightly lighter colored than Mansker fine sandy loam, 0 to 1 percent slopes, and a little more calcareous. It may also have a few more very shallow spots or outcrops of caliche.

Included in the mapped areas are spots of the very shallow Potter soils, of Portales fine sandy loam, 1 to 3 percent slopes, and of Mansker fine sandy loam, 0 to 1 percent slopes.

Most of the acreage is cultivated, and a few areas are irrigated. The hazards of wind erosion and of sheet and gully erosion are moderate. (Nonirrigated capability unit IVe-4; irrigated capability unit IIIe-7; Mixed Plains range site.)

Mansker loam, 0 to 1 percent slopes (MkA).—This soil occurs in the northern part of the county, within larger areas of Portales loam.

The surface layer of this soil is slightly darker colored than that of Mansker fine sandy loam. The subsoil consists of heavy loam or light clay loam. Below the subsoil, at a depth of about 16 inches, is a layer of caliche that is cemented in places.

Included in the mapped areas are small areas of Mansker loam, 1 to 3 percent slopes, and minor areas of Portales loam, 0 to 1 percent slopes.

Most of the acreage is cultivated, and a few areas are irrigated. The hazard of wind erosion is moderate. (Nonirrigated capability unit IVe-4; irrigated capability unit IIIe-7; Mixed Plains range site.)

Mansker loam, 1 to 3 percent slopes (MkB).—This soil occurs on slopes around playas and on small knolls or ridges within larger areas of Portales loam. It is slightly lighter colored and a little more calcareous than Mansker loam, 0 to 1 percent slopes.

Included in the mapped areas are a few small areas of Mansker loam, 0 to 1 percent slopes, and spots of Portales loam, 1 to 3 percent slopes.

Most of this soil is cultivated. A very small acreage is irrigated. There is a moderate hazard of wind erosion, and a moderate hazard of sheet and gully erosion. (Nonirrigated capability unit IVe-4; irrigated capability unit IIIe-7; Mixed Plains range site.)

Portales Series

The Portales series consists of friable, dark-colored, moderately deep, calcareous, nearly level to gently sloping soils on uplands.

The surface layer of Portales soils is brown or grayish brown. It ranges from 8 to 20 inches in thickness. The upper part—that which is normally moved in tillage—ranges from loamy fine sand to loam in texture and has a granular structure. Below plow depth, the texture ranges from heavy fine sandy loam to light clay loam, and the structure is weak coarse prismatic and granular. In this lower part there are many worm casts.

The subsoil ranges from light sandy clay loam to clay loam in texture, from pale brown to grayish brown in color, and from 10 to 20 inches in thickness. The structure is weak coarse prismatic and granular. There are many worm casts.

The parent material consists of friable plains sediments that contain free lime and many lime concretions.

Drainage is good. Internal drainage is medium, and permeability is moderate to moderately rapid. The water-holding capacity is moderate to good. Fertility is moderate to moderately high. These soils are susceptible to wind erosion, and water erosion is a hazard in the more strongly sloping areas.

Portales soils are lighter colored and more limy than Zita soils. They are darker colored and less limy than Arch soils. They have thicker horizons than Mansker soils. They have less distinct layers than Amarillo and Arvana soils and are grayer. They are less sandy than Gomez soils.

Portales soils occur in all parts of Cochran County. They are suited to cotton, grain sorghum, and other crops, and also to native grass. Most of the acreage is cultivated, and a large acreage is irrigated. Cotton and grain sorghum are the main crops on both irrigated and nonirrigated cropland.

Portales fine sandy loam, 0 to 1 percent slopes (PfA).—This soil occurs throughout the county in playa basins and in broad, very shallow, old stream valleys. It is most extensive in the northern part of the county.

The surface layer of this soil is about 15 inches thick. The plow layer consists of fine sandy loam. In many places the uppermost 3 to 6 inches is coarser textured than before the soil was plowed, because wind has blown away some of the clay and silt particles. The lower part of the surface layer consists of light sandy clay loam. The subsoil, also about 15 inches thick, consists of sandy clay loam. Under it is a thick layer of soft, whitish caliche.

Included in the areas mapped are small spots of Mansker fine sandy loam, 0 to 1 percent slopes, which is less than 20 inches deep over caliche and contains much more caliche gravel. Also included are small areas of Portales fine sandy loam, 1 to 3 percent slopes, and of Zita fine sandy loam, 0 to 1 percent slopes. The inclusions of Zita fine sandy loam appear as dark-colored spots.

Most of the acreage is cultivated, and many areas are irrigated. There is a moderate hazard of wind erosion but very little likelihood of sheet or gully erosion. (Nonirrigated capability unit IIIe-3; irrigated capability unit IIe-4; Mixed Plains range site.)

Portales fine sandy loam, 1 to 3 percent slopes (PfB).—This soil occupies gentle slopes around playas and along old drainageways. It is associated with Portales fine sandy loam, 0 to 1 percent slopes. Most areas are less than 100 acres in size. The slope is generally less than 2 percent.

The surface layer of this soil is slightly lighter colored than that of Portales fine sandy loam, 0 to 1 percent slopes, and the depth to caliche is a little less.

Included in the areas mapped are small spots of Mansker fine sandy loam, 1 to 3 percent slopes, and of Portales fine sandy loam, 0 to 1 percent slopes.

Most of the acreage is cultivated, and many areas are irrigated. There is a moderate hazard of wind erosion and also a moderate hazard of sheet and gully erosion. (Nonirrigated capability unit IIIe-3; irrigated capability unit IIIe-4; Mixed Plains range site.)

Portales loam, 0 to 1 percent slopes (PmA).—This soil occurs in playa basins and in broad, very shallow, old stream valleys in the northern part of the county. It is slightly darker colored than Portales fine sandy loam, 0 to 1 percent slopes, and it has a greater capacity to hold water than the other Portales soils.

The surface layer of this soil is about 15 inches thick. The subsoil consists of light clay loam and is about 15 inches thick. Below the subsoil, at a depth of about 30 inches, is a thick layer of soft, whitish caliche.

Included in the mapped areas are spots of Arch loam, which is light colored; of Mansker loam, 0 to 1 percent slopes, which is less than 20 inches deep over caliche and contains more caliche gravel; of Zita loam, 0 to 1 percent slopes, which is darker colored and less limy; and of Portales loam, 1 to 3 percent slopes.

Most of the acreage is cultivated, and large areas are irrigated. There is a moderate hazard of wind erosion. (Nonirrigated capability unit IIIce-2; irrigated capability unit IIe-3; Mixed Plains range site.)

Portales loam, 1 to 3 percent slopes (PmB).—This soil occupies gentle slopes around playas and along old drainageways. It occurs in the same parts of the county as Portales loam, 0 to 1 percent slopes. Most of the areas are small. The slope is generally less than 2 percent.

The surface layer of this soil is slightly lighter colored than that of Portales loam, 0 to 1 percent slopes, and the depth to the caliche layer is a little less.

Included in the mapped areas are small spots of Mansker loam, 1 to 3 percent slopes, and of Portales loam, 0 to 1 percent slopes.

About half of the acreage is cultivated, and most of the cultivated acreage is irrigated. There is a moderate hazard of wind erosion and also a moderate hazard of sheet and gully erosion. (Nonirrigated capability unit IIIe-4; irrigated capability unit IIIe-3; Mixed Plains range site.)

Potter Series

The Potter series consists of very shallow, light-colored, limy soils. The slope range is 1 to 12 percent, but the slope is commonly between 3 and 8 percent.

The surface layer of Potter soils ranges from fine sandy loam to loam in texture, from pale brown to grayish brown in color, and from 2 to 10 inches in thickness. It is strongly calcareous and contains many caliche pebbles. The structure is weak granular. This layer rests directly on the parent material, which is a thick bed of soft or slightly hard caliche.

Internal drainage and runoff are rapid. Permeability is moderately rapid. The water-holding capacity is low. Natural fertility is low. Potter soils are susceptible to both water erosion and wind erosion.

Potter soils are lighter colored and more limy than Kimbrough soils and are underlain by softer caliche. They are thinner than Mansker and Berthoud soils.

The Potter soils in Cochran County occur mainly on the slopes along Sulphur Draw, in the southeastern part of the county. They are mapped as part of complexes, one with Berthoud soils, described under the heading "Berthoud Series," and one with Tivoli soils, described under the heading "Tivoli Series." They are too steep and too shallow to be suitable for cultivated crops. All of the acreage is in native grass.

Randall Series

The Randall series consists of deep, compact, poorly drained soils in playas. The areas are 3 to 30 acres in size, and they are from 3 to 50 feet below the level of the surrounding plain.

The surface layer of Randall soils ranges from dark brown to very dark gray in color and from 10 to 30 inches in thickness. The color is browner in the sandier soils of the series. This layer is massive in some places but ordinarily has a moderate, medium, blocky structure. The subsoil is dark-gray or gray, sticky clay. It ranges from 10 to 50 inches in thickness and is thicker in the sandier soils of the series. The parent material consists of wet clay sediments.

Drainage is poor. Internal drainage and permeability are very slow. There is no runoff, and water that runs off surrounding soils covers these soils to a depth of a few inches to several feet for periods of a few days to several weeks after rains. Natural fertility is high.

Randall soils are more clayey than Lubbock soils, and they occur in lower positions in the landscape. They are more clayey and more compact than Zita soils. They are more compact, more clayey, and less limy than Arch and Portales soils, and they are much grayer and more clayey than Amarillo soils.

Randall soils occur in many small areas in Cochran County and, although the total acreage is not large, are a prominent feature of the landscape. Many areas are cultivated, and some are irrigated. Small grain and grain sorghum are the main crops. Except in dry years, crops can be grown successfully only if measures are taken to keep water from ponding in these depressions.

Randall soils (Ra).—These soils occur as many small areas that are scattered through the less sandy parts of the county and are most numerous in the northern part.

The surface layer of these soils consists of sticky clay and is about 20 inches thick. In many areas the surface is covered with 1 to 6 inches of overwash material that ranges from sandy loam to clay loam in texture. The subsoil, about 20 inches thick, is like the surface layer except that it is lighter colored. In some areas these soils are calcareous, but in most places they are free of lime.

Included on the map are small areas of Lubbock clay loam and of Randall fine sandy loam, thick surface variant.

These soils are difficult to cultivate. Most of the time, they are either too wet or too dry. Except in dry years, cultivation is possible only if measures are taken to prevent the concentration of water. Some farmers plant these soils to rye or winter wheat to provide grazing during dry periods. Sedges and annual weeds grow on the noncultivated areas. (Capability unit VIw-1.)

Randall fine sandy loam, thick surface variant (Rf).—This soil occurs mainly in areas where the predominant upland soil is Amarillo loamy fine sand. Most of these areas are in the central part of the county.

The surface layer of this soil consists of about 20 inches of fine sandy loam over more clayey material. It is dark brown to very dark gray in color. The subsoil is about 40 inches thick, much thicker than that of normal Randall soils. It consists of gray, sticky clay.

Included on the map are small areas of Lubbock fine sandy loam and of the more clayey Randall soils.

This soil is better suited to cultivation than other Randall soils. It receives less runoff from the surrounding sandy soils. Internal drainage, though very slow, is better than in other soils of the series. Water seldom stands on the surface for more than a day. Productivity may be impaired, however, by the accumulation of sandy material washed from unprotected surrounding soils. Some areas are irrigated in dry periods. Grain sorghum is the main crop. (Nonirrigated capability unit IVw-1; irrigated capability unit IVw-1.)

Spur Series

The Spur series consists of deep, friable, dark-colored, limy, nearly level soils on bottom lands.

The surface layer of Spur soils ranges from fine sandy loam to loam or light clay loam in texture, from brown or dark brown to grayish brown in color, and from 10 to 25 inches in thickness. The structure is weak granular.

The subsoil ranges from loam to clay loam in texture, from brown to grayish brown in color, and from 12 to 30 inches in thickness. The structure is weak granular or weak subangular blocky.

The parent material consists of friable, limy, loamy alluvium that is easily penetrated by plant roots. In places it contains thin layers of more sandy material. The color ranges from light gray to very pale brown or brown.

Natural drainage is good. Internal drainage is medium, and permeability is moderate. The water-holding capacity is good. Natural fertility is high. The soils are slightly susceptible to wind erosion and water erosion.

Spur soils are lighter colored, more limy, and more nearly level than Bippus soils.

Spur soils are of minor extent in Cochran County. They occur in the bottom of Sulphur Draw, which is in the southeastern part of the county. They are not mapped separately but are included in an undifferentiated group with the Bippus soils. The mapping unit is described under the heading "Bippus Series." Most of the acreage is in native grass, but the soils are productive and are well suited to most crops, and a small acreage is cultivated. Grain sorghum is the main crop.

Stegall Series

The Stegall series consists of shallow to moderately deep, dark-colored, firm, nearly level soils that are underlain by hard, platy caliche.

The surface layer of Stegall soils ranges from loam to light clay loam in texture, from brown to dark grayish

brown in color, and from 4 to 10 inches in thickness. This layer has a granular structure or, where it has been plowed, is structureless.

The subsoil contains more clay than the surface layer and is more compact. It ranges from light clay loam to heavy clay loam in texture and is most clayey in the middle part. In color it ranges from reddish brown to dark grayish brown but is most commonly dark brown. In the shallow phase, the subsoil is 6 to 12 inches thick and contains no free lime; in the more nearly typical soils of the series, the subsoil is 15 to 30 inches thick and has free lime in the lower part.

The parent material apparently consists of a thin mantle of calcareous clay loam deposited by the wind over rock-like caliche. The layer of hard caliche is 1 to 2 feet thick and consists of plates or slabs that are 1 to 3 feet across and 2 to 6 inches thick. This hard layer is underlain by several feet of softer, more nearly massive caliche.

Natural drainage is good. Internal drainage is medium, and permeability is slow. The water-holding capacity is low in the shallow phase and good in the deeper soils. Natural fertility is medium to high. The soils are slightly susceptible to wind erosion and water erosion.

Stegall soils ordinarily occur in slightly lower areas than Kimbrough and Arvana soils. They are deeper and more clayey than Kimbrough soils. They are more clayey and less red than Arvana soils.

Stegall soils are of minor extent in Cochran County. Most of the acreage is cultivated, and some small areas are irrigated. If dry farmed, these soils are droughty. Grain sorghum is the main crop. Small grain and cotton can be grown under irrigation. The shallow phase is much better suited to native grass than to cultivated crops.

Stegall loam, 0 to 1 percent slopes (StA).—This soil occurs mainly in the northeastern part of the county, mostly between ridges of Kimbrough soils. The total acreage is very small.

The surface layer of this soil is about 7 inches thick. The subsoil consists of clay loam and is about 20 inches thick; the lower part contains free lime.

Included on the map are small areas of Stegall loam, shallow, 0 to 1 percent slopes, and scattered spots of Arvana fine sandy loam, 0 to 1 percent slopes.

Although this soil is droughty, most of it is dry farmed. A small acreage is in native grass, mainly blue grama and buffalograss. (Nonirrigated capability unit IIIce-1; irrigated capability unit IIe-1; Deep Hardland range site.)

Stegall loam, shallow, 0 to 1 percent slopes (SwA).—This soil occurs in the northern part of the county, mostly near ridges of Kimbrough soils. The total acreage is small.

This soil is slightly redder in color than Stegall loam, 0 to 1 percent slopes. It is also 10 to 12 inches shallower. The surface layer is about 5 inches thick. The subsoil consists of clay loam and is about 10 inches thick. The depth to the caliche ranges from 10 to 20 inches.

Included on the map are small areas of Stegall loam, 0 to 1 percent slopes; of Kimbrough soils; and of Arvana fine sandy loam, shallow, 0 to 1 percent slopes. Also included are small areas of Stegall loam, shallow, that have slopes ranging up to 2 percent.

This soil is best suited to range. Nevertheless, most of it is cultivated, and some areas are irrigated. Grain sorghum is the main dryland crop. Some cotton and small grain, as well as grain sorghum, are grown under irrigation. Yields are rather low. Caliche rocks scattered through the plow layer interfere with the use of tillage equipment. Terracing and leveling are difficult because the hard caliche is near the surface. (Nonirrigated capability unit IVe-4; irrigated capability unit IIIe-7; Deep Hardland range site.)

Tivoli Series

The Tivoli series consists of deep, loose, light-colored sands. These soils occur as dunes that are 6 to 30 feet high and have short choppy slopes of as much as 30 percent.

The surface layer of Tivoli soils consists of loose fine sand and is 4 to 10 inches thick. The color ranges from brown to pale brown, light brown, or light yellowish brown. The surface layer is directly over the parent material, which consists of windblown fine sand that is easily penetrated by plant roots. This layer ranges in color from light brown to yellow, very pale brown, or yellowish red. It is neutral or mildly alkaline in reaction.

These soils are excessively drained. Internal drainage and permeability are very rapid. The water-holding capacity is very low. Natural fertility is low. The hazard of wind erosion is severe.

Tivoli soils are much more sandy below the surface layer than the closely associated Brownfield soils, which have a subsoil of sandy clay loam.

Tivoli soils occur in the southern and western parts of Cochran County. They are not suitable for cultivation because of the risk of wind erosion. All of the acreage is in native grass, principally tall bunchgrass. Careful range management is needed to prevent blowouts from forming and spreading.

Tivoli fine sand (Tv).—This soil occurs as large areas in the southern and western parts of the county. It consists of many connected dunes. Included in mapping are areas of Brownfield fine sand, thick surface, and small eroded or blownout spots of Tivoli fine sand. All of the acreage is in tall native grass. (Capability unit VIIe-1; Deep Sand range site.)

Tivoli-Potter complex (Tx).—This complex occurs along the slopes of two draws that are within large areas of Amarillo loamy fine sand. It consists of an intricate mixture of Tivoli, Potter, Amarillo, Brownfield, Berthoud, Gomez, and Mansker soils. All of these soils are covered with a deposit of light-brown or brown sand or loamy sand blown from areas of Amarillo, Brownfield, and Tivoli soils. This deposit ranges from 8 to 40 inches in thickness but is most commonly between 15 and 25 inches thick.

Mansker, Potter, and Berthoud soils occupy the steeper part of the slopes; they have a gradient of 3 to 8 percent. Gomez soils are in the bottom of the draws. Amarillo and Brownfield soils are along the outer edges of the slopes. Tivoli soils and sand dunes are scattered throughout the mapping unit.

These soils are not suitable for cultivation, because the steep slopes and the sandy surface layer make them highly susceptible to wind erosion and water erosion. Small gullies have formed in some areas. Nearly all the acreage

is in native grass. (Capability unit VIIe-1; Tivoli soils are in the Deep Sand range site, and Potter soils are in the Shallow Land range site. As a whole, however, this complex has the aspect of the Sandy Land range site.)

Zita Series

The Zita series consists of moderately deep, dark-colored, friable, nearly level to gently sloping soils that occur in old valleys and in playas.

The surface layer of Zita soils is dark brown or dark grayish brown and is 12 to 24 inches thick. The upper part—the plow layer or its equivalent in unplowed areas—ranges in texture from fine sandy loam to loam and has a weak granular structure. The lower part is light sandy clay loam or medium clay loam and has a weak, coarse, prismatic structure that breaks to granules. The entire surface layer is noncalcareous but mildly alkaline. It generally contains many worm casts.

The subsoil consists of light sandy clay loam or medium clay loam. It ranges from grayish brown to pale brown in color and from 4 to 12 inches in thickness. This layer is calcareous. The structure is granular.

The parent material consists of friable, limy plains sediments that appear to have been enriched with lime from a high water table. The upper part of the parent material is a thick layer of friable white caliche.

Natural drainage is good. Internal drainage is medium, and permeability is moderate. The water-holding capacity is good. Natural fertility is high. These soils are susceptible to wind erosion, and the more strongly sloping areas are somewhat susceptible to water erosion.

Zita soils are darker colored than the nearby Portales soils and are more deeply leached of lime. They are grayer than Amarillo soils. They are deeper, darker colored, and less limy than Mansker and Arch soils. They have a less clayey and less distinct subsoil than Lubbock soils.

Zita soils occur in the northern part of Cochran County and as a few scattered areas in other parts. They are well suited to both dryland and irrigated crops and also to native grass. Most of the acreage is cultivated, and a large acreage is irrigated. Cotton and grain sorghum are the main crops, but small grain and alfalfa are grown under irrigation.

Zita fine sandy loam, 0 to 1 percent slopes (ZfA).—This soil occurs on nearly level benches around playas and in broad, very shallow, old stream valleys, mainly in the northern part of the county.

The surface layer of Zita soils is about 20 inches thick. In the lower part, it grades to light sandy clay loam. The subsoil consists of limy light clay loam.

Included on the map are small areas of Portales fine sandy loam, 0 to 1 percent slopes; of Lubbock fine sandy loam; and of Zita fine sandy loam, 1 to 3 percent slopes.

This is a productive soil, and yields normally are good. Three-fourths of the acreage is cultivated, and a large proportion is irrigated. The hazard of wind erosion is moderate. In some areas, the wind has blown some of the clay and silt particles from the plow layer, which is now coarser textured than it was before it was cultivated. (Nonirrigated capability unit IIIe-1; irrigated capability unit IIe-2; Mixed Land range site.)

Zita fine sandy loam, 1 to 3 percent slopes (ZfB).—This soil occurs on gentle slopes around playas, mainly in the northern part of the county. The areas are much smaller than those of Zita fine sandy loam, 0 to 1 percent slopes. The slope is generally less than 2 percent. The surface layer is about 15 inches thick and is a little lighter colored than that of Zita fine sandy loam, 0 to 1 percent slopes.

Included in the areas mapped are small spots of Portales fine sandy loam, 1 to 3 percent slopes, and of Zita fine sandy loam, 0 to 1 percent slopes.

Most of the acreage is cultivated, and some is irrigated. Grain sorghum is the main crop. The hazard of wind erosion is moderate, and the hazard of water erosion is greater than on Zita fine sandy loam, 0 to 1 percent slopes. (Nonirrigated capability unit IIIe-1; irrigated capability unit IIIe-2; Mixed Land range site.)

Zita loam, 0 to 1 percent slopes (ZmA).—This soil occurs in the northern part of the county. It is associated with Zita fine sandy loam, 0 to 1 percent slopes.

The surface layer is about 18 inches thick. The lower part is light clay loam. The subsoil consists of limy clay loam.

Included in the areas mapped are a few small spots of Portales loam; of Lubbock clay loam; and of Zita loam that has a slope of slightly more than 1 percent.

This soil is productive if irrigated. If dry farmed, it tends to be droughty. Most of the acreage is cultivated, and a large proportion is irrigated. Cotton and grain sorghum are the main crops. The hazard of wind erosion is slight. (Nonirrigated capability unit IIIce-1; irrigated capability unit IIe-1; Deep Hardland range site.)

Use and Management of the Soils

In this section the use and management of the soils as irrigated cropland, as nonirrigated cropland, and as range are discussed. The major limitations and management requirements are described briefly. The capability grouping used by the Soil Conservation Service is explained, the soils of the county are grouped according to their suitability for crops, both with and without irrigation, and estimated yields of the major crops are given. The soils are also grouped according to the kind and amount of forage they produce if used as range. Finally, the relative suitability of the soils for highways and other engineering structures is discussed.

Wind Erosion and Its Control

No farm in Cochran County is safe from damage by high winds. The danger of wind erosion has a major influence on soil management. Effective control of wind erosion requires the cooperation of all farmers in an area, because soil blown from unprotected fields damages the soils on adjoining farms.

Effects of wind erosion

Wind erosion has serious and extensive effects. Crop yields decline, and many crops are lost. Railways and highways are sometimes buried under drifted soil. Traffic accidents are common during duststorms. Insects and weed seeds are blown far and wide. Fences, hedges, and

Figure 9.—**Soil material covering fence and drifting into road after only two duststorms in 1960.**

Figure 10.—**Line-drift dune along fence row has covered fence. Vegetation is weeds and brush.**

shelterbelts are sometimes buried or ruined (fig. 9). At times, farm buildings are ruined by drifts and sand blasting.

Wind erosion removes the fine soil particles (silt, clay, and organic matter) and leaves the coarser particles (sand). The fine particles are what enables a soil to hold moisture and plant nutrients and to form stable aggregates. Each shift of the soil by the wind removes more of the fine particles; consequently, the soil becomes more and more susceptible to further erosion and has less and less capacity to hold water and plant nutrients. Whatever the original texture, eventually only sand remains, piled in hummocks and fence-row dunes.

The finer textured soils (loams and clay loams) are least susceptible to wind erosion because tillage usually roughens and clods them so that they resist blowing. Wind winnowing has, nevertheless, removed enough of the organic matter, silt, and clay to make the surface layer in most cultivated areas coarser textured than when first cultivated.

Most cultivated areas of fine sandy loams have been similarly affected. Wind erosion has removed much of the organic matter, silt, and clay from the plow layer. What soil remains is sandy, lacks plant nutrients, and is highly susceptible to wind erosion. To offset these effects, farmers have plowed deeper to bring more clayey material into the surface layer. In many areas this process has been repeated so many times that the texture of the surface layer, to a depth of 10 to 12 inches, probably has changed from fine sandy loam to loamy fine sand.

Wind erosion has had its most drastic effects on the loamy fine sands and fine sands. In cultivated areas, line-drift sand dunes up to 10 feet high are common (fig. 10). Some abandoned fields have lost all of the thick sandy surface layer. The blowing of sterile sand from these areas to adjoining areas of more productive soils is especially damaging.

Range also shows the effects of wind erosion. Some of the soil is shifted or removed, but generally soil material is blown onto the range from cultivated areas. In some places several areas are covered with 6 inches to 3 feet of sand, which has smothered the grass and allowed weeds and brush to invade.

One of the least noticeable but most damaging effects of wind erosion is the blowing of clay and silt from cultivated areas to range. This material is carried many miles and deposited as a thin mantle on the range. Though only ⅛ to ½ inch thick, this mantle is almost impervious to water. It increases runoff and water erosion and thus takes greatly needed moisture from the grass.

Types of wind erosion

There are three main types of soil movement caused by wind: (1) floating, (2) bouncing, and (3) creeping. During a duststorm, soil may float, or move in the air. This is the type of movement that is usually noticed. The bouncing of particles causes the other two types of movement. Particles the size of very fine to medium sand are moved directly by the wind, in a series of short bounces. These particles, in turn, may cause larger particles to creep along the surface as they strike them, or they may detach, lift, and suspend in the air particles the size of clay and silt. Material that moves by bouncing or creeping stays near its place of origin (*4*).[1] Material that is suspended in the air may be blown hundreds of miles.

Control of wind erosion

In some parts of Cochran County, the soils are so severely eroded that they are no longer cultivated (fig. 11). It is evident that the soils in many other places will eventually erode to the same degree unless wind erosion is controlled.

The best way to control wind erosion is to keep the surface covered with growing vegetation or with crop residues. Stubble left in the fields slows down the wind at the surface. Standing stubble reduces the force of the wind more than flattened stubble, and closely spaced stubble reduces it more than widely spaced stubble.

When the soils are bare, the surface should be kept rough and cloddy, by emergency tillage if necessary. The rougher the surface, the stronger the wind needed to start the soils blowing. The degree of protection that can be provided by tillage depends on the capacity of the soils to form clods, and clod formation is directly related to texture. Soils that have already lost most of their clay

[1] Italic numbers in parentheses refer to Literature Cited, p. 77.

Figure 11.—**A field of Brownfield soils, severely eroded, that has been cultivated, then abandoned.**

and organic matter will not form stable aggregrates. Clods the size of alfalfa seeds (0.84 millimeter) resist blowing. Normally, no more than 12 percent of the clods in sandy soils are that large. In fine sandy loam soils the proportion is between 12 and 35 percent, and in loam and clay loam soils it is about 50 percent. Generally, coarse textured soils are more than 8 times as erodible as moderately coarse textured soils and more than 40 times as erodible as those that are medium textured or fine textured.

Methods of emergency tillage and the use of crops and residues for the control of erosion and for soil improvement are discussed under the heading "General Management of Cultivated Soils."

General Management of Cultivated Soils

Control of wind and water erosion, conservation of moisture, maintenance of fertility, and preservation of tilth are the main objectives of the management practices that are described briefly in the following paragraphs. Wind erosion is such a serious hazard in Cochran County that it has been discussed in the preceding subsection, in more detail than other hazards.

All of the practices are discussed in general terms. The local representatives of the Soil Conservation Service and the county agent are available to help plan the application of these practices on specific farms and ranches.

Management of residues

Proper management of crop residues helps to conserve moisture, to maintain the organic-matter content, and to improve tilth, but the main objective is the control of wind erosion. There are three methods of managing residues to achieve these ends.

Crop residue use consists of managing residues on the surface of the soil through the critical erosion period. In Cochran County, this period lasts until April 1 or until the seedbed is prepared. Then the residues are destroyed or plowed under in normal farming operations. Residues of small grain, sorghum, perennial grass, and some legumes can be used effectively under this system.

Stubble mulching is a system that calls for year-round management of residues. Under this system, all farming operations, including tillage, planting, and cultivating, are carried on so as to leave as much residue as possible on the soil surface. Small grain, sorghum, perennial grass, and some legumes leave residues that can be used effectively under this system.

Mulching, the third system of residue management, consists of applying cotton burs, hay, or other residues in amounts large enough to control erosion. This practice is limited by the availability of material.

Tillage for control of wind erosion

Row crops grown under normal dryland farming conditions do not ordinarily leave enough residue to protect the soils against blowing. Emergency tillage and deep plowing are supplemental measures that provide temporary control.

Emergency tillage should be resorted to only when there is immediate danger of damage by wind erosion. Its purpose is to roughen and clod the surface, so that the soils will resist blowing. The effect is temporary. Rain, snow, or a duststorm can destroy many of the clods and make it necessary to repeat the tillage operation. Listers, chisels, pitters, sand fighters, rotary hoes, and stalk cutters are among the kinds of farm machinery used for emergency tillage.

Deep plowing is a method of increasing the clay content of the surface layer of coarse-textured soils enough so that clods will form. Deep plowing is effective only if one-fourth to one-third of the furrow slice is clayey material. Mixing the clayey material with the sandy surface layer forms a fine sandy loam plow layer. If tilled at the right time after plowing, this layer will form stable clods large enough to resist erosion.

Soils that have been deep plowed must be protected with crop residues or must be kept rough and cloddy; otherwise, they will start to blow and drift again. Deep plowing can be repeated, but it is effective only as long as clayey material is within reach of the plow. After that, the soil is left with a deep surface layer of sand that is more susceptible to erosion than the original surface layer.

Calcareous soils should not be deep plowed, because soil material that is high in lime will not form clods stable enough to resist wind erosion.

Terraces

Terraces help to conserve moisture and to control water erosion. Conservation of moisture is extremely important in this area of low and erratic rainfall. The moisture saved from one rainfall by terracing can increase yields significantly.

Water erosion is a hazard on the stronger slopes in the county, and also on very long slopes even if the gradient is slight (fig. 12). Loss of surface soil through water erosion reduces fertility, impairs the water-absorbing capacity, and increases the rate of runoff.

Contour farming

Contour farming also helps to conserve moisture and to control erosion. All terraced fields should be contour farmed, and nearly level fields that do not need to be terraced are benefited by contour farming (fig. 13). Even

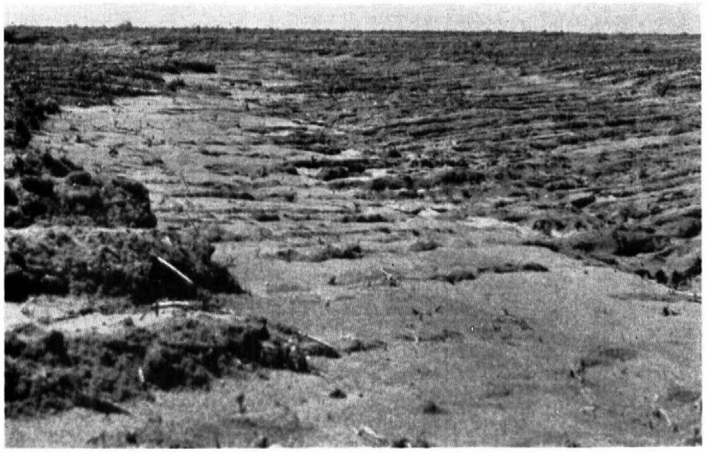

Figure 12.—Evidence of water erosion on Amarillo fine sandy loam, 1 to 3 percent slopes. Loss of soil could have been prevented by terracing.

some irrigated fields that are watered by sprinkler systems should be terraced and contour farmed to control erosion.

Grassed waterways

In this county grassed waterways are generally needed to carry outside water safely across farms. Most of the large gullies have been caused by water washing from road right-of-ways across farms to playa lakes (fig. 14).

Tillage practices

Frequent tillage destroys the structure of soils. It produces a powdery surface layer that does not absorb water readily, is easily eroded by wind, and tends to crust. Ordinarily, till only enough to prepare a good seedbed and to control weeds. If you use flame cultivation or chemicals to control weeds, you may not need to till so often. Sometimes tillage is required for the control of wind erosion.

A tillage pan forms below the plow layer in some of the soils in Cochran County, most commonly in the moderately coarse textured soils. If a soil is always tilled

Figure 13.—Cotton and fallow strips on contour, for control of water erosion and conservation of moisture. Grain sorghum residue in fallow strips. Next year grain will be planted where cotton is, and cotton will be planted on another part of the farm. Strips should not be left fallow on highly erodible soils.

Figure 14.—Large gully caused by water washing from roadway to playa lake. A grassed waterway is needed here.

to the same depth, the bottom of the plow layer may acquire a sheared, slick surface. Tractor wheels compress the plow layer, particularly if the soil is moist. The combination of these factors results in a hardpan layer so dense that it restricts growth of roots and movement of water (fig. 15).

To prevent a pan from forming, vary the depth of plowing and other tillage operations, and do not till when the soil is wet. Growing deep-rooted legumes or grasses may help to prevent the formation of a pan or to break up an existing one (fig. 16).

Use of amendments

Amendments are natural or manufactured materials added to soils for the purpose of improving or maintaining soil condition, of stimulating plant growth, and of reducing losses of soil and water. Amendments commonly used in Cochran County include commercial fertilizer, barnyard manure, and cotton burs.

Most of the irrigated soils in Cochran County need nitrogen and phosphorus, and some need potassium. The proper use of fertilizer can be expected to increase yields of irrigated cotton and grain sorghum significantly. Because the growing season is short for cotton, part of the nitrogen and all of the phosphorus should be applied before the cotton is planted. If the crop is early, it should

be sidedressed with nitrogen when the first squares appear. If the crop is late, this sidedressing of nitrogen should not be applied, because it could delay maturity of the crop. Fertilizer applied to row crops is most effective if it is banded to the side of and below the seed.

Fertilizer is not generally used on nonirrigated soils, because lack of moisture, not low fertility, is the factor that limits yields. Recent field tests have shown, however, that sandy soils respond to applications of fertilizer in seasons when there is adequate moisture.

All applications of fertilizer should be based on needs determined by soil tests. Requirements vary widely, depending on the soils, the crop to be grown, the crop previously grown, and the season.

Barnyard manure provides nutrients that plants need, and it also improves the condition of the soil. It is in short supply in Cochran County, but some is available from dairy farms and commercial feedlots.

Areas from which part or all of the topsoil has been removed by leveling should receive heavy applications of gin trash or barnyard manure, or else they should be well fertilized and planted to a soil-improving crop the first year after being leveled. Highly erodible spots, which may include turnrows, ridges, odd corners, and sandy areas, need the same kind of treatment, repeated as often as is necessary to control erosion.

High-lime spots usually need iron and sulfate fertilizer. Spraying iron solution on crops, as needed, is generally

Figure 15.—Hard tillage pan that restricts growth of cotton roots in Amarillo fine sandy loam.

Figure 16.—Deep-rooted legumes help to keep the soil porous and permeable.

more economical than applying iron solution to the soil, where it quickly becomes unavailable to plants. High-lime spots also respond to heavy applications of barnyard manure, but it is usually more profitable to apply the available manure to better soils, from which the returns are greater.

Cropping systems and rotations

A cropping system consists of a rotation or sequence in which soil-improving crops balance soil-depleting crops in their effect on the soil. Soil-improving crops are those that return large amounts of residue to the soil. How often the high-residue crop is grown depends on the severity of the erosion hazard. A conservation cropping system must control erosion, maintain productivity, and keep the soil in good physical condition.

In this county, a cropping system suitable for nonirrigated soils must be based on the two major crops, cotton and grain sorghum. Cotton, a low-residue crop, is grown in rotation with grain sorghum, which is a high-residue crop. The sorghum residue can be managed for the protection and improvement of the soils.

In dryland farming, crop sequences like the following generally provide plenty of residue for the control of wind erosion.

1. On soils that are slightly susceptible to wind erosion—1 year of cotton followed by 1 year of grain sorghum.

2. On soils that are moderately susceptible to wind erosion—1 year of cotton followed by 2 years of grain sorghum.
3. On soils that are highly susceptible to wind erosion—grain sorghum grown continuously in closely spaced rows.

Other high-residue crops are small grain, millet, sudan, and perennial grass.

Summer legumes, such as cowpeas, mungbeans, and guar, improve the soils so that yields of crops that follow are increased, but they leave little residue to help control wind erosion. Cowpeas or mungbeans interplanted with grain sorghum improve the soil.

All dryland rotations are suited to irrigated soils. The following are additional rotations that are possible for irrigated soils:

1. On soils that are slightly susceptible to wind erosion—
   a. 2 years of cotton; 3 years of alfalfa.
   b. 2 years of cotton; 1 year of grain sorghum interplanted with cowpeas.
2. On soils that are moderately to highly susceptible to wind erosion—
   a. 1 year of cotton; 3 years of alfalfa; 1 year of cotton; 1 year of grain sorghum.
   b. 1 year of cotton (overseeded in fall with vetch or rye or both); 1 year of cotton; 1 year of grain sorghum.
3. On soils that are very highly susceptible to wind erosion—
   a. 3 years of alfalfa; 3 years of grain sorghum in closely spaced rows.
   b. 3 years of perennial grass; 3 years of grain sorghum interplanted with cowpeas or mungbeans.

Other suitable rotations can be planned. The county agent or a representative of the Soil Conservation Service can be consulted about suitable cropping systems.

Stripcropping, a practice used with rotation of crops, is the alternating of strips of crops that provide enough cover to control erosion with strips of crops that do not. Some of the protective crops suitable for use in a stripcropping system are sorghum, sudan, tall perennial grass, and tall legumes.

Cover crops are close-growing crops planted between regular crops, mainly for the purpose of protecting the soils against wind and water erosion. Small grain, vetch, Austrian winter peas, and sweetclover are among the suitable cover crops for Cochran County. If possible, these crops should be planted in fall and left on the ground until April 1 or later. Many farmers overseed cotton at the last cultivation in August with one or more of the above crops.

Besides providing protection against erosion, cover crops help to improve the physical, chemical, and biological condition of the soils.

Irrigation

The purpose of irrigation is to make it possible to apply water in the needed amounts at the right time and to distribute water uniformly. A properly designed irrigation system makes efficient use of the available water and helps to maintain or increase the productivity of the soils. It does not cause erosion, waterlogging, or excessive leaching of plant nutrients.

The following factors are among those that must be considered in designing a system for irrigation:

1. The quality and quantity of the available water.
2. How fast the soils will take water, and how much water they will hold.
3. The water needs of the crops to be grown.
4. The topography of the areas to be irrigated.

There are two main types of irrigation systems: sprinkler and surface. A sprinkler system is better for sandy soils, shallow soils, and soils with complex slopes that cannot be leveled economically. Terracing and contour farming to control erosion are advisable on some sprinkler irrigated soils.

A surface irrigation system is suitable for deep, nearly level, loamy soils that take in water at a rate of less than 2 inches per hour, hold more than 1 inch of water per foot of depth, and have a slope of less than 1 percent. Leveling the fields, or at least the borders, may be necessary. Water can be carried to the fields in underground pipe, in portable pipe, or even in open ditches if seepage losses are not too great.

It is advisable to have an irrigation system designed by a qualified engineer to make sure that the system will make the best use of the available water and be suitable for the soils and the crops.

Capability Groups of Soils

The capability classification is a grouping of soils that shows, in a general way, how suitable they are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, grazing, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion; *w* means that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the country, indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it have little or no erosion hazard but have other limitations that limit their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally identified by numbers assigned locally, for example, IIIe-2.

Soils are classified in capability classes, subclasses, and units according to the degree and kind of their permanent limitations, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils, and without consideration of possible but unlikely major reclamation projects.

Many of the soils of Cochran County can be put in a more favorable capability class if irrigated than if not irrigated. Consequently, two sets of capability units are described. In the first, all the soils of the county are classified according to their capability when not irrigated. In the second, the soils suitable for irrigation are classified according to their capability when irrigated.

Nonirrigated soils

Classes in the capability system, and the subclasses and units for nonirrigated soils in Cochran County, are given in the following list. Following the list are descriptions of the units, including suggestions for managing the soil for dryland farming.

Class I.—Soils that have few limitations that restrict their use. No soil of Cochran County is in class I.

Class II.—Soils that have some limitations that reduce the choice of plants or require moderate conservation practices. No soil of Cochran County is in class II unless it is irrigated; see list on p. 30.

Class III.—Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

- Subclass IIIce.—Soils that have a moderate climatic hazard of low rainfall and a slight to moderate risk of erosion.
  - Unit IIIce-1.—Deep and moderately deep, reddish-brown to dark-brown, nearly level loams and clay loams.
  - Unit IIIce-2.—Moderately deep, grayish-brown, nearly level, calcareous loams.
- Subclass IIIe.—Soils that are subject to erosion if they are not protected.
  - Unit IIIe-1.—Deep and moderately deep, reddish-brown to grayish-brown, level to gently sloping, well-drained fine sandy loams.
  - Unit IIIe-2.—Deep, reddish-brown, gently sloping, well-drained loams.
  - Unit IIIe-3.—Moderately deep, nearly level to gently sloping, grayish-brown, calcareous fine sandy loams.
  - Unit IIIe-4.—Moderately deep, gently sloping, grayish-brown, calcareous loams.

Class IV.—Soils that have very severe limitations that restrict the choice of plants, or require very careful management, or both.

- Subclass IVe.—Soils subject to severe erosion if not protected.
  - Unit IVe-1.—Deep, reddish-brown, moderately sloping fine sandy loams.
  - Unit IVe-2.—Deep, brown, nearly level to gently undulating loamy fine sands.
  - Unit IVe-3.—Deep, light-brown, gently undulating fine sands.
  - Unit IVe-4.—Shallow, reddish-brown to grayish-brown, nearly level to gently sloping loams and fine sandy loams.
- Subclass IVes.—Soils that are subject to very severe erosion and that have a high lime content that limits their use.
  - Unit IVes-1.—Nearly level to gently sloping, high-lime soils.
- Subclass IVw.—Soils that have very severe limitations because of excess water.
  - Unit IVw-1.—Deep, dark-colored, poorly drained, fine sandy loams in playas.

Class V.—Soils subject to little or no erosion hazard but having other limitations impractical to remove that limit their use largely to pasture, range, woodland, or wildlife food and cover. No soil in Cochran County is in class V.

Class VI.—Soils that have severe limitations that make them generally unsuitable for cultivation and limit their use largely to range, woodland, or wildlife food and cover.

- Subclass IVe.—Soils that are severely limited in use, mainly by risk of erosion if they are not protected.
  - Unit VIe-1.—Gently sloping and moderately sloping, high-lime soils.
  - Unit VIe-2. Deep, light-brown to brown, undulating fine sands.
  - Unit VIe-3. Moderately deep to very shallow, nearly level to moderately sloping soils.
- Subclass VIw.—Soils that are very limited in use because of excess water.
  - Unit VIw-1.—Deep, dark-gray, very poorly drained clays in playas.

Class VII.—Soils that have very severe limitations that make them generally unsuitable for cultivation and that restrict their use largely to grazing, woodland, or wildlife.

- Subclass VIIe.—Soils that are very severely limited in use, mainly by risk of erosion if they are not protected.
  - Unit VIIe-1.—Deep, light-brown, undulating and duned fine sands.
- Subclass VIIs.—Soils that are very severely limited in use, mainly by shallowness and stoniness.
  - Unit VIIs-1.—Very shallow, nearly level to gently sloping soils.

Class VIII.—Soils and landforms that have limitations that preclude their use, without major reclamation, for commercial production of plants and restrict their use to recreation, wildlife, water supply, or esthetic purposes. No soil in Cochran County is in class VIII.

CAPABILITY UNIT IIIce-1 (NONIRRIGATED)

This unit consists of soils that are deep and moderately deep, reddish brown to dark brown, nearly level, and moderately to slowly permeable. These soils are—

Amarillo loam, 0 to 1 percent slopes.
Lubbock clay loam.

Stegall loam, 0 to 1 percent slopes.
Zita loam, 0 to 1 percent slopes.

These soils occur mainly in the northern part of the county. They are well suited to cultivation, and about 80 percent of their acreage is cultivated. Inadequate rainfall limits yields in some years.

Cotton is the main cash crop. Grain sorghum is another cash crop. Sorghum leaves large amounts of residues which, if kept on the surface and properly managed, help to control wind erosion.

These soils have a high capacity to hold water and plant nutrients, but they are slightly susceptible to wind erosion. They require management that will (1) maintain or increase the content of organic matter, and (2) either maintain a cover that will control wind erosion, or keep the surface rough and cloddy so that it will resist wind erosion.

A crop that leaves large amounts of residues should be grown every other year. If the cropping system will not permit the growing of a high-residue crop, a mulch of cotton burs or other residues may be applied. Chiseling or listing to make the surface rough and cloddy may be necessary, if the amount of cover produced is not enough to keep the soil from blowing.

Lack of moisture, not lack of fertility, limits production on these soils. Farming on the contour and constructing a good system of terraces on long slopes will help to save moisture.

CAPABILITY UNIT IIIce-2 (NONIRRIGATED)

This unit consists of one moderately deep, grayish-brown, nearly level, friable, calcareous soil. This soil is well drained and moderately permeable. It is—

Portales loam, 0 to 1 percent slopes.

This soil occurs mainly in the northern part of the county. About 80 percent of it is cultivated. It is well suited to cultivation, but inadequate rainfall limits yields in some years.

Cotton and grain sorghum are the main cash crops. Grain sorghum leaves large amounts of residues which, if left on the surface and properly managed, help to control wind erosion.

This soil has a moderately high capacity to hold water and plant nutrients, but it is moderately susceptible to wind erosion. The surface layer contains lime; consequently, it does not form stable aggregates, and it blows readily. A cropping system is needed that will (1) maintain or increase the content of organic matter, and (2) either maintain a cover that will control wind erosion, or keep the surface rough and cloddy so that it will resist wind erosion.

A crop that leaves large amounts of residues should be grown about 3 years in 5. If the cropping system does not include a high-residue crop, a mulch of cotton burs or other residues may be applied. If the cover produced is not sufficient to keep the soil from blowing, chiseling or listing may be necessary to make the surface rough and cloddy. This emergency tillage has only a temporary effect and may have to be repeated several times during the windy season.

Lack of moisture, not lack of fertility, limits production on this soil. Farming on the contour or building terraces on long slopes will save moisture.

CAPABILITY UNIT IIIe-1 (NONIRRIGATED)

This unit consists of deep and moderately deep, reddish-brown to grayish-brown, level to gently sloping soils that are well drained and moderately to slowly permeable. These soils are—

Amarillo fine sandy loam, 0 to 1 percent slopes.
Amarillo fine sandy loam, 1 to 3 percent slopes.
Arvana fine sandy loam, 0 to 1 percent slopes.
Arvana fine sandy loam, 1 to 3 percent slopes.
Bippus and Spur soils.
Lubbock fine sandy loam.
Zita fine sandy loam, 0 to 1 percent slopes.
Zita fine sandy loam, 1 to 3 percent slopes.

These soils occur throughout the county and occupy about 40 percent of the acreage. They are productive if properly managed and are suited to most of the common crops. More than 60 percent of the acreage is cultivated.

Cotton and grain sorghum are the main crops. Grain sorghum produces large amounts of residues which, if left on the surface and properly managed, help to control wind erosion.

These soils have a moderate to high capacity to hold water and plant nutrients, but they are moderately susceptible to wind erosion. They require management that will (1) either maintain a cover that will control wind erosion, or keep the surface rough and cloddy so that it will resist wind erosion, (2) maintain or increase the content of organic matter, and (3) prevent runoff.

A crop that leaves large amounts of residues should be grown 2 years in 3. Proper use of the residues adds organic matter to the soil and also controls wind erosion. If stripcropping is practiced, a high-residue crop is needed only every other year. A mulch of cotton burs or other residues may be applied if the cropping system does not include a high-residue crop. Listing or chiseling may be necessary if the amount of cover produced is not sufficient to control erosion. This emergency tillage has only a temporary effect, and it may have to be repeated during the windy season.

A plowpan is likely to form in some of these soils, especially in the Amarillo fine sandy loams. Deep chiseling breaks up the pan, but for only a year or two. Growing deep-rooted legumes or perennial grasses in the cropping system is more effective; this breaks up the pan and prevents the formation of a new one.

Lack of moisture, not lack of fertility, limits production on these soils. Terracing and farming on the contour are ways of conserving moisture. Terracing also helps to keep the more strongly sloping soils from eroding. It may not be necessary if small grain or grain sorghum is grown each year in closely spaced rows.

CAPABILITY UNIT IIIe-2 (NONIRRIGATED)

This unit consists of one deep, reddish-brown, gently sloping, well-drained, moderately permeable soil. This soil is—

Amarillo loam, 1 to 2 percent slopes.

This soil is of minor extent. It occurs in the northern part of the county. It is well suited to cultivation, but inadequate rainfall limits yields. Only about 20 percent of the acreage is cultivated.

Because of the slope, more of this soil is used for grain sorghum than for cotton. Careful management of crop residue is necessary to help control wind and water erosion.

These soils have a high capacity to hold water and plant nutrients, but they are moderately susceptible to water erosion and slightly susceptible to wind erosion. They require management that will (1) maintain or increase the content of organic matter, (2) either maintain a cover that will control wind erosion, or keep the surface rough and cloddy so that it will resist wind erosion, and (3) prevent runoff.

A crop that leaves large amounts of residues should be grown about 3 years in 5. If this high-residue crop is drilled, sowed, or planted in closely spaced rows, it may be needed only every other year. A mulch of cotton burs may be applied if the cropping system does not include a high-residue crop. Listing or chiseling may be necessary if the amount of cover produced is not sufficient to control erosion.

Most areas of this soil need a good system of terraces that will conserve moisture and control erosion. Terraces may not be needed on short slopes that are planted to grain sorghum or small grain each year or that are seeded to grass. Farming on the contour also helps to save moisture and to prevent erosion.

CAPABILITY UNIT IIIe-3 (NONIRRIGATED)

This unit consists of moderately deep, nearly level to gently sloping, calcareous soils that have a moderately rapidly permeable subsoil of loam to sandy clay loam. These soils are—

Portales fine sandy loam, 0 to 1 percent slopes.
Portales fine sandy loam, 1 to 3 percent slopes.

These soils occur throughout the county and occupy about 7 percent of the acreage. If well managed they are suited to most of the crops commonly grown in the area. More than 80 percent of their acreage is cultivated.

Cotton and grain sorghum are the main crops. Grain sorghum leaves large amounts of crop residues which, if properly managed, help to control wind erosion.

These soils have a moderate capacity to hold water and plant nutrients. They are moderately susceptible to wind erosion. The surface layer contains lime; consequently, it does not form stable aggregates and blows readily.

A crop that leaves large amounts of residues should be grown 2 years in 3. If stripcropping is practical, a high-residue crop is needed only every other year. A mulch of cotton burs or other residues may be applied if the cropping system does not include a high-residue crop. Listing or chiseling may be necessary if the amount of cover produced is not sufficient to control erosion. This emergency tillage has only a temporary effect, and it may have to be repeated during the windy season.

Terracing and contour farming help to control water erosion on the more strongly sloping areas. These practices benefit the more nearly level areas also, by helping to conserve moisture.

CAPABILITY UNIT IIIe-4 (NONIRRIGATED)

This unit consists of one moderately deep, grayish-brown, gently sloping, well-drained, calcareous soil that is porous, friable, and moderately permeable. This soil is—

Portales loam, 1 to 3 percent slopes.

This soil is of minor extent. It occurs in the northern part of the county. It is well suited to crops, but inadequate rainfall often limits yields. About half the acreage is cultivated.

Because of the slope, more of this soil is used for grain sorghum than for cotton. Careful management of crop residues is necessary for the control of wind erosion and water erosion.

This soil has a moderately high capacity to hold water and plant nutrients. It is moderately susceptible to wind erosion and water erosion. The surface soil contains lime; consequently, it does not form stable aggregates and blows readily.

A crop that leaves large amounts of residues should be grown about 3 years in 5. This high-residue crop may be needed only every other year if it is drilled, sowed, or planted in closely spaced rows. A mulch of cotton burs may be applied if the cropping system does not include a high-residue crop. If the amount of cover produced is not sufficient to control erosion, listing or chiseling may be necessary.

Terracing and contour farming help to save moisture and to prevent erosion. Terraces may not be needed on short slopes that are planted to grain sorghum or small grain each year or that are seeded to grass.

CAPABILITY UNIT IVe-1 (NONIRRIGATED)

This unit consists of one deep, reddish-brown, moderately sloping, moderately permeable soil. This soil is—

Amarillo fine sandy loam, 3 to 5 percent slopes.

This soil is of minor extent. It occurs on slopes around the deeper playas. Because of its slope, it is much better suited to range than to cultivated crops. It is highly susceptible to water erosion and moderately susceptible to wind erosion. Under cultivation, it needs to be terraced, farmed on the contour, and used only for high-residue crops. A small part is now under cultivation but should be returned to grass.

CAPABILITY UNIT IVe-2 (NONIRRIGATED)

This unit consists of deep, nearly level to gently undulating, well-drained soils that have a light-brown or brown surface layer and a reddish-brown or pale-brown subsoil. Permeability is moderate to moderately rapid. These soils are—

Amarillo loamy fine sand, 0 to 3 percent slopes.
Gomez and Portales soils.

These soils are most extensive across the central part of the county. They occupy about one-fourth of the county. Less than half the acreage is cultivated. Because of the sandy texture, more acreage is used for grain sorghum than for cotton.

These soils have a low to moderate capacity to hold water and plant nutrients and are highly susceptible to wind erosion. They require management that will (1) maintain or increase the content of organic matter, (2) either maintain enough cover to control wind erosion, or keep the surface rough and cloddy so it will resist wind erosion, and (3) prevent runoff.

A cover of growing crops or of crop residues is the best means of controlling erosion. If the crop grown does not leave enough residue, a mulch of cotton burs may be applied. Tillage to roughen the surface may be necessary if the cover of vegetation is inadequate. If there is evi-

dence of water erosion, terracing and contour farming may be needed.

Plowing the Amarillo soil to a depth of 16 to 20 inches increases the clay content of the surface layer, thus making it cloddy and increasing its resistance to wind erosion. Gomez and Portales soils should not be deep plowed, because deep plowing would increase the lime content of the surface layer and make it more susceptible to blowing.

Grass, small grain, or closely spaced sorghum are crops that provide a protective cover. Only for the Amarillo soil, which can be deep plowed effectively, is a more flexible cropping system suitable. On this soil, cotton, which is a low-residue crop, can be grown about once in 4 years. Where stripcropping is practical, cotton can be grown once in 3 years.

In years of average rainfall, applying phosphate and nitrogen to these soils is beneficial. Soil tests should be made to determine how much fertilizer can be used profitably.

CAPABILITY UNIT IVe-3 (NONIRRIGATED)

This unit consists of one deep, gently undulating, well-drained, moderately permeable soil that has a light-brown surface layer and a red or yellowish-red subsoil. This soil is—

Brownfield fine sand, thin surface.

Most of this soil is in the southwestern part of the county. Its total acreage is about 5 percent of the county. About 15 percent is cultivated. Because this soil is sandy, much more of it is in grain sorghum than in cotton.

This soil has a lower capacity to hold water and plant nutrients than the Amarillo soil in unit IVe-2. It is also more easily eroded by wind. It requires management that will (1) maintain or increase the content of organic matter and (2) either maintain enough cover to control wind erosion, or keep the surface rough and cloddy so it will resist wind erosion.

Maintaining a cover of growing crops or crop residues is the best way to control erosion. A mulch of cotton burs may be applied if the crop grown does not supply enough residue. Tillage to roughen the surface may be necessary if the soil begins to blow. Where feasible, this soil should be deep plowed to increase the clay content of the surface layer, but in some places the subsoil is at too great a depth to be reached in deep plowing.

Cotton can be grown about once in 4 years in areas that can be deep plowed effectively. Perennial grass, drilled small grain, and grain sorghum planted in closely spaced rows are suitable crops for other areas.

In years when the rainfall is average or above, applying nitrogen and phosphate is beneficial. Soil tests should be made to determine how much fertilizer can be used profitably.

CAPABILITY UNIT IVe-4 (NONIRRIGATED)

This unit consists of shallow, reddish-brown to grayish-brown, nearly level to gently sloping, well-drained soils. Permeability ranges from slow to moderately rapid. The soils are—

Arvana fine sandy loam, shallow, 0 to 1 percent slopes.
Mansker fine sandy loam, 0 to 1 percent slopes.
Mansker fine sandy loam, 1 to 3 percent slopes.
Mansker loam, 0 to 1 percent slopes.
Mansker loam, 1 to 3 percent slopes.
Stegall loam, shallow, 0 to 1 percent slopes.

These soils occupy less than 1 percent of the acreage of the county. They occur as many small areas within larger areas of deeper soils. Consequently, although they are better suited to grass than to cultivated crops, about 85 percent of the acreage is cultivated along with the deeper soils in the same fields. In areas large enough to be managed separately, the main crops are grain sorghum and small grain, both of which leave large amounts of residues. Under careful management, a crop such as cotton can be grown occasionally.

These soils have a low to moderate capacity to hold water and plant nutrients. They are moderately susceptible to wind erosion and water erosion. Careful management is required to control erosion and to maintain fertility. Crop residues should be left on the surface and utilized to control erosion. Where there is evidence of water erosion, terraces should be constructed or closely spaced crops should be grown every year. Because the soils are shallow over hard caliche, some areas cannot be terraced.

CAPABILITY UNIT IVes-1 (NONIRRIGATED)

This unit consists of nearly level to gently sloping, light-gray to grayish-brown soils that are high in lime. These soils are—

Arch fine sandy loam.
Arch loam.
Drake soils, 1 to 3 percent slopes.

These soils occur mainly in the northern part of the county, but they are found in small areas throughout the county. Their productive capacity is low to moderate. They are best suited to perennial grasses and close-growing crops.

These soils have a low to moderate ability to hold water and plant nutrients. Some of the nutrients, especially iron, are not readily available to plants. Yellow leaves on plants indicate the shortage of iron. The hazard of wind erosion is moderate to severe, and the hazard of water erosion is moderate. Careful management is necessary to control erosion and to maintain fertility. Residues should be left on the surface. If there is evidence of water erosion, terracing and contour farming are advisable.

CAPABILITY UNIT IVw-1 (NONIRRIGATED)

This unit consists of one deep, dark-brown to very dark gray, level, poorly drained soil that is very slowly permeable. This soil is—

Randall fine sandy loam, thick surface variant.

This soil is of minor extent. It occurs in small playas throughout the county. Although runoff from higher areas collects on it, the soil is seldom completely covered with water, and even after a heavy rain the surface normally is dry within a week. Cultivation is practical except in years of unusually high rainfall. Grain sorghum is the main crop. Yields are generally high.

This soil has a high capacity to hold water and plant nutrients. It can be cultivated along with the adjoining soils if runoff from surrounding slopes is controlled. In areas that are flooded frequently, small grain can be grown for grazing, but it may have to be replanted after each flooding.

CAPABILITY UNIT VIe-1 (NONIRRIGATED)

This unit consists of gently sloping and moderately sloping, light-gray to grayish-brown, high-lime soils. These soils are—

Drake soils, 3 to 5 percent slopes.
Drake soils, 5 to 8 percent slopes.

These soils are limited in extent. They occur as small areas in many parts of the county. They are used mainly for range. Because of the severe hazard of wind erosion and water erosion, they are unsuited to cultivation.

As range, these soils need careful management that will control erosion. Mechanical measures for range improvement are not feasible. The best way to maintain a good stand of grass is through control of grazing. Range improvement is indicated by an increase in blue grama and a decrease in weeds. (High Lime range site.)

CAPABILITY UNIT VIe-2 (NONIRRIGATED)

This unit consists of deep, undulating, light-brown to brown fine sands, some areas of which are eroded. These soils are—

Brownfield fine sand, thick surface.
Brownfield soils, severely eroded.

These soils are most extensive in the southern part of the county. They are used mainly for range. Because of the severe hazard of wind erosion, they are unsuited to cultivation.

As range, these soils use moisture efficiently and are well suited to tall native grass. Eroded areas need to be reseeded to native grass and protected from grazing until the grass is well established. Mechanical measures for range improvement are not feasible. The best way to maintain a good stand of grass is through control of grazing. Cross fences, water, and salt should be carefully placed to get even distribution of grazing. Shrubs that have invaded overgrazed areas can be controlled by spraying with herbicides. (Deep Sand range site.)

CAPABILITY UNIT VIe-3 (NONIRRIGATED)

This unit consists of very shallow to moderately deep, pale-brown to grayish-brown, nearly level to moderately sloping, calcareous fine sandy loams. These soils are—

Berthoud-Potter complex.

These soils occupy only a small acreage. They occur mostly along Sulphur Draw and are used for range. They are highly susceptible to water erosion. Mechanical measures for range improvement are not feasible. Control of grazing is the best way to keep a good stand of grass. (Berthoud soils are in the Mixed Plains range site; Potter soils are in the Shallow Land range site.)

CAPABILITY UNIT VIw-1 (NONIRRIGATED)

This unit consists of deep, dark-gray, level, very poorly drained, very slowly permeable clay soils in playas. These soils are—

Randall soils.

These soils occur in playa beds throughout the county. Flooding by runoff from surrounding areas makes farming hazardous. Some areas can be farmed during long dry spells, or if runoff is controlled. The areas that can be farmed can be managed in the same way as the soil in capability unit IVw-1.

CAPABILITY UNIT VIIe-1 (NONIRRIGATED)

This unit consists of deep, light-brown, undulating and duned fine sands. A few areas are very shallow. These soils are —

Brownfield-Tivoli fine sands.
Tivoli fine sand.
Tivoli-Potter complex.

These soils occur in the southern and western parts of the county. They are not suited to cultivation, because of the very severe hazard of wind erosion, but they are well suited to range if properly managed. They produce tall native grass and use the available moisture efficiently.

Mechanical measures for range improvement are not feasible. The best way to maintain a good stand of grass is through control of grazing. Shrubs that have invaded overgrazed areas can be controlled by spraying with herbicides.

(Brownfield and Tivoli soils are in the Deep Sand range site; Potter soils are in the Shallow Land range site; but the Tivoli-Potter complex has a Sandy Land range site aspect.)

CAPABILITY UNIT VIIs—1 (NONIRRIGATED)

This unit consists of very shallow, nearly level to gently sloping soils. These soils are—

Kimbrough soils.

These inextensive soils occur in the northern part of the county. They are less than 10 inches deep and consequently are unsuited to cultivation.

As range, these soils support a limited amount of vegetation and need careful control of grazing. Pitting or chiseling to catch extra water and thereby increase plant growth is not practical on these very shallow soils. Overgrazed areas may be infested with broom snakeweed. This noxious plant can be controlled by spraying. (Shallow Land range site.)

Irrigated soils

The soils suitable for irrigation have been placed in capability classes, subclasses, and units as listed below.

Class II.—Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.
- Subclass IIe.—Soils that have a slight to moderate risk of erosion if they are not protected.
  - Unit IIe-1.—Deep and moderately deep, reddish-brown to dark-brown, nearly level, well-drained loams and clay loams.
  - Unit IIe-2.—Deep and moderately deep, reddish-brown to grayish-brown, nearly level, well-drained fine sandy loams.
  - Unit IIe-3.—Moderately deep, grayish-brown, nearly level, calcareous loams.
  - Unit IIe-4.—Moderately deep, grayish-brown, nearly level, calcareous fine sandy loams.

Class III.—Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.
- Subclass IIIe.—Soils susceptible to erosion if they are not protected.
  - Unit IIIe-1.—Deep, reddish-brown, gently sloping loams.

Unit IIIe-2.—Deep and moderately deep, reddish-brown to dark-brown, gently sloping fine sandy loams.
Unit IIIe-3.—Moderately deep, gently sloping, grayish-brown, calcareous loams.
Unit IIIe-4.—Moderately deep, gently sloping, grayish-brown, calcareous fine sandy loams.
Unit IIIe-5.—Deep, brown, nearly level to gently undulating, well-drained loamy fine sands.
Unit IIIe-6.—Deep, light-brown, gently undulating fine sands.
Unit IIIe-7.—Shallow, reddish-brown to grayish-brown, nearly level to gently sloping loams and fine sandy loams.

Subclass IIIes.—Soils that are susceptible to erosion and have a high content of lime that limits their use.
Unit IIIes-1.—Nearly level to gently sloping, high-lime soils.

Class IV.—Soils that have very severe limitations that restrict the choice of plants, or require very careful management, or both.

Subclass IVe.—Soils susceptible to very severe erosion if they are not protected.
Unit IVe-1.—Deep, reddish-brown, moderately sloping fine sandy loams.
Unit IVe-2.—Moderately sloping, high-lime soils.
Unit IVe-3.—Deep and moderately deep, light-brown to brown, nearly level to undulating fine sands and loamy fine sands.

Subclass IVw.—Soils that have very severe limitations because of excess water.
Unit IVw-1.—Deep, dark-colored, poorly drained fine sandy loams in playas.

CAPABILITY UNIT IIe-1 (IRRIGATED)

This unit consists of deep and moderately deep, reddish-brown to dark-brown, nearly level soils that are slowly to moderately permeable. These soils are—

Amarillo loam, 0 to 1 percent slopes.
Lubbock clay loam.
Stegall loam, 0 to 1 percent slopes.
Zita loam, 0 to 1 percent slopes.

These soils are located in the northern part of the county. They are well suited to cultivation and are productive of all crops adapted to the area.

Cotton is the main cash crop. Grain sorghum is also grown as a cash crop. Sorghum leaves large amounts of crop residues which, if kept on the surface and properly managed, help to control wind erosion. Vetch, sweetclover, cowpeas, and alfalfa are legumes that can be used to improve the soils.

These soils have a high capacity to hold water and plant nutrients. They are slightly susceptible to wind erosion. They need management that will (1) maintain or increase the content of organic matter, and (2) either maintain enough cover to control wind erosion, or keep the surface rough and cloddy so it will resist erosion.

A crop that leaves large amounts of residues or one that improves the soils should be grown about 1 year in every 3 years. If the cropping system does not include a high-residue crop, a mulch of cotton burs or other residues may be applied. Commercial fertilizer is usually needed to help maintain productivity. The amount of fertilizer to be applied is best determined by a soil test.

These soils lend themselves to either surface or sprinkler irrigation. Which system to use depends on several factors, including the lay of the land, the cost of leveling, and the kind of crops to be grown. Local representatives of the Soil Conservation Service will help in planning systems for individual farms.

CAPABILITY UNIT IIe-2 (IRRIGATED)

This unit consists of deep and moderately deep, reddish-brown to grayish-brown, nearly level, well-drained soils that are slowly to moderately permeable. These soils are—

Amarillo fine sandy loam, 0 to 1 percent slopes.
Arvana fine sandy loam, 0 to 1 percent slopes.
Bippus and Spur soils.
Lubbock fine sandy loam.
Zita fine sandy loam, 0 to 1 percent slopes.

These soils are well suited to cultivation and are productive of all crops adapted to the area.

Cotton is the main cash crop. Grain sorghum is also grown as a cash crop. Sorghum leaves large amounts of crop residues which, if kept on the surface and properly managed, help to control wind erosion. Vetch, sweetclover, cowpeas, and alfalfa are legumes that can be used to improve these soils.

These soils have a moderate to high capacity to hold water and plant nutrients. They are moderately susceptible to wind erosion. They need management that will (1) maintain or increase the content of organic matter, and (2) either maintain enough cover to control wind erosion, or keep the surface rough and cloddy so it will resist wind erosion.

A crop that leaves large amounts of residues or one that improves the soils should be grown about 1 year in every 3 years. If the cropping system does not include a high-residue crop, a mulch of cotton burs or other residues may be applied. Commercial fertilizers are usually needed to help maintain productivity. The amounts to be applied are best determined by a soil test.

These soils lend themselves to either surface or sprinkler irrigation. Which system to use depends on several factors, including the lay of the land, the cost of leveling, and the kinds of crops to be grown. Local representatives of the Soil Conservation Service will help in planning systems for individual farms.

A tillage pan may form in some of these soils. Deep chiseling breaks up a pan but for only a year or two. Growing deep-rooted legumes or perennial grasses in the cropping system is more effective; this breaks up a pan and prevents the formation of a new one.

CAPABILITY UNIT IIe-3 (IRRIGATED)

The one soil in this unit is moderately deep, nearly level, grayish-brown, porous, friable, and calcareous. This soil is—

Portales loam, 0 to 1 percent slopes.

This soil is located in the northern part of the county. It is well suited to cultivation and is productive of all crops adapted to the area.

Cotton is the main cash crop grown on this soil. Grain sorghum is also grown as a cash crop. Sorghum leaves

large amounts of residues which, if kept on the surface and properly managed, help to control wind erosion. Vetch, sweetclover, cowpeas, and alfalfa are legumes that can be used to improve the soil.

This soil has a moderately high capacity to hold water and plant nutrients. It is moderately susceptible to wind erosion. The surface layer contains lime; consequently, it does not form stable aggregates and blows readily. A high-residue crop should be grown at least 2 years in 5. If the cropping system does not include a high-residue crop, a mulch of cotton burs or other residues may be applied. Occasionally a cover crop may be grown to control erosion. Commercial fertilizers are usually needed to help maintain productivity. The amounts to be applied are best determined by a soil test.

This soil lends itself to either surface or sprinkler irrigation.

CAPABILITY UNIT IIe-4 (IRRIGATED)

The one soil in this unit is moderately deep, nearly level, grayish brown, porous, friable and calcareous. This soil is—

Portales fine sandy loam, 0 to 1 percent slopes.

This soil is productive of the crops adapted to the area. Cotton and grain sorghum are the main crops.

This soil has a moderate capacity to hold water and plant nutrients. It is moderately susceptible to wind erosion. The surface layer contains lime; consequently, it does not form stable aggregates and blows readily.

A high-residue crop should be grown every other year to help keep the soil from blowing. A mulch of cotton burs or other residues may be applied to take the place of the high-residue crop. Sometimes a cover crop of small grain or legumes may be planted to control erosion. A soil-improving crop, such as vetch, sweetclover, cowpeas, or alfalfa, is also beneficial. Commercial fertilizers are usually needed to help maintain productivity. The amounts to be applied are best determined by a soil test.

This soil lends itself to either surface or sprinkler irrigation. Usually pipelines are needed to deliver the water to the field. Much water is lost in open ditches on this permeable soil.

CAPABILITY UNIT IIIe-1 (IRRIGATED)

The one soil in this unit is deep, reddish brown, gently sloping, well drained, and moderately permeable. This soil is—

Amarillo loam, 1 to 2 percent slopes.

This soil is in the northern part of the county. If properly managed, it is well suited to cultivation and is productive of all crops adapted to the area.

Cotton is the main cash crop. Grain sorghum is also grown as a cash crop. Sorghum leaves large amounts of residues which, if kept on the surface and properly managed, help to control wind and water erosion. Vetch, sweetclover, cowpeas, and alfalfa are legumes that can be used to improve the soil.

This soil has a high capacity to hold water and plant nutrients. It is moderately susceptible to water erosion and slightly susceptible to wind erosion. It needs management that will (1) maintain or increase the content of organic matter, (2) either maintain enough cover to control wind erosion, or keep the surface rough and cloddy so it will resist wind erosion; and (3) prevent runoff.

A high-residue crop or a crop that improves the soil should be grown every other year. If the cropping system does not include a high-residue crop, a mulch of cotton burs or other residues can be applied. Commercial fertilizers are usually needed to help maintain productivity. The amounts to be applied are best determined by a soil test.

This soil lends itself to either surface or sprinkler irrigation. Graded or level borders may be needed as a part of a surface system.

CAPABILITY UNIT IIIe-2 (IRRIGATED)

This unit consists of deep and moderately deep, reddish-brown to dark-brown, gently sloping, well-drained, moderately permeable soils. These soils are—

Amarillo fine sandy loam, 1 to 3 percent slopes.
Arvana fine sandy loam, 1 to 3 percent slopes.
Zita fine sandy loam, 1 to 3 percent slopes.

These soils are well suited to cultivation if properly managed and are productive of all crops adapted to the area.

Because of the slope, more acreage is used for grain sorghum than for cotton. Careful management of crop residues is necessary to help control wind and water erosion. Vetch, sweetclover, cowpeas, and alfalfa are legumes that can be used to improve the soils.

These soils have a moderate to high capacity to hold water and plant nutrients. They are moderately susceptible to wind and water erosion. They need management that will (1) maintain or increase the content of organic matter, (2) either maintain enough cover to control wind erosion, or keep the surface rough and cloddy so it will resist wind erosion, and (3) prevent runoff.

A crop that leaves large amounts of residues or one that improves the soils should be grown once in 2 years. If the cropping system does include a high-residue crop, a mulch of cotton burs or other residues may be applied. Commercial fertilizers are usually needed to help maintain productivity. The amounts to be applied are best determined by a soil test.

These soils are better suited to sprinkler irrigation than to surface irrigation, though either system can be used. Local representatives of the Soil Conservation Service can help in planning systems for individual farms.

CAPABILITY UNIT IIIe-3 (IRRIGATED)

The one soil in this unit is moderately deep, gently sloping, grayish brown, porous, friable, and calcareous. This soil is—

Portales loam, 1 to 3 percent slopes.

This soil is of minor extent and is found in the northern part of the county. It is productive of crops adapted to the area.

Cotton is the main cash crop. Grain sorghum is also grown as a cash crop. Sorghum leaves large amounts of crop residues which, if kept on the surface and properly managed, help to control wind and water erosion. Vetch, sweetclover, cowpeas, and alfalfa are legumes that can be used to improve the soils.

This soil has a moderately high capacity to hold water and plant nutrients. It is moderately susceptible to wind and water erosion. The surface soil contains lime; con-

sequently, it does not form stable aggregates and blows readily.

A high-residue crop should be grown 3 years in 5. Cotton burs may be used as a mulch in the place of the high-residue crop. Commercial fertilizers are usually needed to help maintain productivity. The amounts to be applied are best determined by a soil test.

This soil lends itself to either surface or sprinkler irrigation.

CAPABILITY UNIT IIIe-4 (IRRIGATED)

The one soil in this unit is moderately deep, gently sloping, grayish brown, porous, friable, and calcareous. This soil is—

Portales fine sandy loam, 1 to 3 percent slopes.

This soil has a moderate capacity to hold water and plant nutrients. It is moderately susceptible to wind and water erosion. The surface layer contains lime; consequently, it does not form stable aggregates and blows easily.

A high-residue crop should be grown, and the residues should be kept on the surface and carefully managed so they will help to control wind and water erosion. A mulch of cotton burs or other residues may be applied if high-residue crops are not grown. A soil-improving crop, such as vetch, sweetclover, cowpeas, or alfalfa, is also beneficial. Commercial fertilizers are usually needed to help maintain productivity.

This soil is better suited to sprinkler irrigation than to surface irrigation, but a surface system can be used.

CAPABILITY UNIT IIIe-5 (IRRIGATED)

The one soil in this unit is deep, nearly level to gently undulating, well drained, and moderately permeable. This soil is—

Amarillo loamy fine sand, 0 to 3 percent slopes.

This soil is most extensive across the central part of the county. It is moderately productive of most crops adapted to the area. Careful management is needed to control erosion and maintain fertility.

Cotton is the main cash crop. Grain sorghum is another cash crop. Sorghum leaves large amounts of crop residues, which, if kept on the surface and properly managed, help to control wind erosion. Legumes or perennial grasses can be used to improve the soil.

This soil has a low to moderate capacity to hold water and plant nutrients. It is highly susceptible to wind erosion. It needs management that will (1) maintain or increase the content of organic matter, and (2) either maintain enough cover to control wind erosion or keep the surface rough and cloddy so it will resist wind erosion.

Plowing to a depth of 16 to 20 inches will increase the clay content of the surface layer, and thus make it cloddy and increase its resistance to wind erosion. A crop that leaves large amounts of residues should be grown about half the time.

Areas that are not deep plowed need a cover of growing crops or crop residues. A high-residue crop should be grown 2 years in 3. If the cropping system does not include a high-residue crop, a mulch of cotton burs or other residues may be applied. Commercial fertilizers are usually needed to help maintain productivity. The amounts to be applied are best determined by a soil test.

Sprinkling is the only system of irrigation to which this sandy soil is suited.

CAPABILITY UNIT IIIe-6 (IRRIGATED)

The one soil in this unit is deep, gently undulating, well drained, and moderately permeable. This soil is—

Brownfield fine sand, thin surface.

This soil is of minor extent and occurs in the southwestern part of the county. It is low to moderate in productivity. Careful management is needed for control of erosion and for maintenance of fertility.

Cotton is grown occasionally on this soil, but grain sorghum is the main crop. Sorghum leaves large amounts of residues which, if kept on the surface and properly managed, help to control wind erosion. Legumes or perennial grasses can be used to improve the soil.

This soil has a low to moderate capacity to hold water and plant nutrients. It is highly susceptible to wind erosion. It needs management that will (1) maintain or increase the content of organic matter, and (2) either maintain enough cover to control wind erosion, or keep the surface rough and cloddy so it will resist wind erosion.

Where feasible, this soil should be deep plowed to increase the clay content of the surface layer. A crop that leaves large amounts of residues or one that improves the soil is needed about 1 year in 2. Areas not suitable for deep plowing need a high-residue crop each year. A mulch of cotton burs or other residues may be applied if the crop grown does not leave enough residue to control erosion. A mulch helps also to maintain productivity. Commercial fertilizers are usually needed to help maintain productivity. The amounts to be applied are best determined by a soil test.

Sprinkling is the only system of irrigation suitable for this sandy soil.

CAPABILITY UNIT IIIe-7 (IRRIGATED)

This unit consists of shallow, reddish-brown to grayish-brown, nearly level to gently sloping, well-drained soils that have slow to moderately rapid permeability. These soils are—

Arvana fine sandy loam, shallow, 0 to 1 percent slopes.
Mansker fine sandy loam, 0 to 1 percent slopes.
Mansker fine sandy loam, 1 to 3 percent slopes.
Mansker loam, 0 to 1 percent slopes.
Mansker loam, 1 to 3 percent slopes.
Stegall loam, shallow, 0 to 1 percent slopes.

These soils occur as small areas in most parts of the county. They are low to moderate in productive capacity and need careful management for the control of erosion and maintenance of fertility.

Cotton is grown occasionally on these soils, but grain sorghum is the main crop. Sorghum leaves large amounts of residues which, if kept on the surface and properly managed, help to control wind and water erosion. Legumes or perennial grasses can be used to improve the soils.

These soils have a low to moderate capacity to hold water and plant nutrients. They are moderately susceptible to wind and water erosion. They need management that will (1) maintain or increase the content of organic matter, (2) either maintain enough cover to control wind erosion or keep the surface rough and cloddy so it will resist wind erosion, and (3) prevent runoff.

A crop that leaves large amounts of residues or one that improves the soils should be grown about 2 years in 3. If the cropping system does not include a high-residue crop, a mulch of cotton burs or other residues may be applied. Commercial fertilizers are usually needed to help maintain productivity. The amounts to be applied are best determined by a soil test.

These soils lend themselves to either surface or sprinkler irrigation. Because of the limited water-holding capacity, they need small, frequent waterings.

CAPABILITY UNIT IIIes-1 (IRRIGATED)

This unit consists of nearly level to gently sloping, light-gray to grayish-brown, high-lime soils. These soils are—

Arch fine sandy loam.
Arch loam.
Drake soils, 1 to 3 percent slopes.

These soils occur mainly in the northern part of the county. They are low to moderate in productive capacity. They are best suited to legumes and perennial grasses.

Cotton is occasionally grown on these soils, but grain sorghum is the main crop.

These soils have a low to moderate capacity to hold water and plant nutrients. Some of the nutrients, especially iron, are not readily available to plants. Yellow leaves on plants indicate the lack of iron. The hazards of wind erosion and of water erosion are moderate. Management is needed that will (1) maintain or increase the content of organic matter, (2) either maintain enough cover to control wind erosion, or keep the surface rough and cloddy so it will resist wind erosion, and (3) prevent runoff.

A crop that leaves large amounts of residues or one that improves the soils should be grown about 2 years in 3. If the cropping system does not include a high-residue crop, a mulch of cotton burs or other residues may be applied. Commercial fertilizers are usually needed to help maintain productivity. The amounts to be applied are best determined by a soil test.

These soils lend themselves to either surface or sprinkler irrigation. Because of their limited water-holding capacity, they need small, frequent waterings, for which a sprinkler system is better.

CAPABILITY UNIT IVe-1 (IRRIGATED)

The one soil in this unit is deep, reddish brown, moderately sloping, and moderately permeable. This soil is—

Amarillo fine sandy loam, 3 to 5 percent slopes.

This soil is of very minor extent. It occurs on the slopes around the deeper playas. It is highly susceptible to water erosion and moderately susceptible to wind erosion. It is much better suited to perennial grass than to cultivated crops.

Large amounts of residues are needed for the control of erosion. A high-residue crop should be grown each year. Perennial grass, small grain, and grain sorghum are suitable. A mulch of cotton burs may be needed to supplement the residues. Commercial fertilizers are usually needed to help maintain productivity. The amounts to be applied are best determined by a soil test.

A sprinkler system is the best means of irrigating this soil.

CAPABILITY UNIT IVe-2 (IRRIGATED)

This unit consists of one complex of moderately sloping, light-gray, high-lime soils. This complex is—

Drake soils, 3 to 5 percent slopes.

These soils are limited in extent. They occur as small areas in many parts of the county. They are low in productive capacity. They are better suited to perennial grass than to cultivated crops.

These soils have a low capacity to hold water and plant nutrients. Moreover, some nutrients, especially iron, are not readily available to plants. Yellow leaves on the plants show this lack of iron. The hazards of wind erosion and water erosion are severe.

Large amounts of residues are needed for the control of erosion. A high-residue crop is needed each year. This crop should be drilled or seeded in closely spaced rows. Perennial grass, small grain, and grain sorghum are suitable. A mulch of cotton burs may be needed to supplement the residues. Commercial fertilizers are usually needed to help maintain productivity. The amounts to be applied should be determined by a soil test.

Because of their limited water-holding capacity, these soils need small, frequent waterings. Consequently, sprinklers are the best means of irrigation.

CAPABILITY UNIT IVe-3 (IRRIGATED)

This unit consists of light-brown or brown, nearly level to undulating fine sands and loamy fine sands. These soils are—

Brownfield fine sand, thick surface.
Gomez and Portales soils.

These soils occur in the southern part of the county. They are low in productive capacity. They are much better suited to perennial grass than to cultivated crops. It is not practical to attempt to increase the clay content of the thick sandy surface layer by deep plowing.

These soils have a low capacity to hold water and plant nutrients. They are very susceptible to wind erosion.

A cover of growing crops or of crop residues is the best means of controlling erosion. Only high-residue crops, such as perennial grass, small grain, and grain sorghum, are suitable. Alfalfa may also be grown. A mulch of cotton burs may be needed to supplement crop residues. Commercial fertilizers are needed to help maintain productivity. The amounts to be applied are best determined by a soil test.

A sprinkler system is the only suitable means of irrigating these sandy soils. Only a small acreage is irrigated.

CAPABILITY UNIT IVw-1 (IRRIGATED)

The one soil in this unit is deep, dark brown to very dark gray, level, poorly drained, and very slowly permeable. This soil is—

Randall fine sandy loam, thick surface variant.

This soil is minor in extent. It occurs in small playas throughout the county. Although runoff from higher areas collects on it, this soil is seldom completely covered by water, and even after a heavy rain the surface normally is dry within a week. Cultivation is practical ex-

cept in years of unusually high rainfall. Grain sorghum is the main crop. Generally, yields are high.

This soil has a high capacity to hold water and plant nutrients. It can be irrigated and cultivated along with the adjoining soils if runoff from surrounding slopes is controlled.

In areas that are flooded frequently, small grain can be grown for grazing, but it may have to be replanted after each flooding.

Estimated Yields

Table 2 shows estimated average yields per acre of the principal crops, on irrigated and nonirrigated soils, under two levels of management.

The figures in columns A are estimates of yields to be expected under the following practices.

For nonirrigated soils—
1. Tillage alone is depended on for the control of wind erosion.
2. No particular effort is made to conserve water.
3. No soil-building crops are included in the cropping system.

For irrigated soils—
1. No effort is made to save rainfall.
2. Crop residues are turned under.
3. Irrigation is erratic and is not planned to meet the needs of crops.
4. Fertilizer either is not used or is used haphazardly.

The figures in columns B are estimates of yields to be expected under improved management that includes the following practices.

For nonirrigated soils—
1. Rainfall is saved.
2. Crop residues are used to help control wind erosion.
3. Fertility is improved, and high-residue crops are included in the cropping system.

For irrigated soils—
1. A conservation irrigation system is used to save all rainfall and to supply water according to crop needs.
2. Fertilizer is used in amounts determined by soil analysis and crop needs.
3. Crop residues are used to help control wind erosion.
4. Fertility is improved, and high-residue crops are included in the cropping system.
5. Improved methods of farming are used, and improved varieties of crops are planted.

Nearly all farmers in Cochran County use improved methods of controlling insects, weeds, and plant diseases.

Range Management[2]

Approximately half of the acreage of Cochran County is rangeland. Some 90 percent of the ranching units are cow-calf enterprises. The rest run stocker-steers. Between 5,000 and 8,000 cattle are "fed out" annually in feedlots. Locally produced feed is used. Native grass pasture is sometimes supplemented with irrigated pasture. Grass grown in irrigated pastures can be used for production of seed as well as to provide supplemental forage for livestock (fig. 17).

Range sites and condition classes

Soils differ in their capacity to produce grass and other plants for grazing. The soils that will produce about the same kind and amount of forage if the range is in similar condition make up what is called a range site.

Range sites are kinds of rangeland that differ from each other in their capacity to produce vegetation. All the soils in any one range site produce about the same kind of climax vegetation. Climax vegetation is the stabilized plant community on a particular site; it reproduces itself and does not change so long as the environment does not change. Throughout most of the plains and the prairies, the climax vegetation consists of the plants that were growing there when the region was first settled. Generally, the climax vegetation is the most productive combination of forage plants that will grow on a range site.

Decreasers are species in the climax vegetation that tend to decrease in relative amount under close grazing. They generally are the tallest and most productive of the perennial grasses and forbs and are the most palatable to livestock.

Increasers are species in the climax vegetation that increase in relative amount as the more desirable plants are reduced by close grazing. They are commonly shorter than the decreasers, and some are less palatable to livestock.

Invaders are plants that cannot withstand the competition for moisture, nutrients, and light in the climax vegetation. Hence, they come in and grow along with the increasers after the decreasers have been reduced by grazing. Many are annual weeds. Some are shrubs that have some grazing value, but others have little value for grazing.

Grass, like all other plants, manufactures its food in its leaves and stems. If the leaves and stems are destroyed by continuous heavy grazing, the grasses do not have food for growth and maintenance. As the most palatable and nutritious grasses are reduced under heavy grazing, the composition of the vegetation on a range site changes, and the condition of the range declines as the decreasers are replaced by increasers and invaders.

Four classes of range condition are used to indicate the degree to which the climax vegetation has been changed by grazing or other use.

A range is in *excellent condition* if more than 75 percent of the present vegetation consists of climax plants. It is in *good condition* if the percentage is between 51 and 75, in *fair condition* if the percentage is between 26 and 50, and in poor condition if the percentage is less than 25.

Potential forage production depends on the range site. Current production depends on range condition and moisture supply. A major problem in managing range so as to keep it in good or excellent condition is recognizing important changes in the vegetation. These changes take place gradually and can be misunderstood or overlooked. Growth encouraged by a heavy rainfall may lead to the conclusion that the range is in good condition, when

[2] By JOE B. NORRIS, range conservationist, Soil Conservation Service, Lubbock, Tex.

TABLE 2.--ESTIMATED AVERAGE ACRE YIELDS, ON NONIRRIGATED AND IRRIGATED SOILS, UNDER TWO LEVELS OF MANAGEMENT

Soil	Capability unit		Nonirrigated soils				Irrigated soils			
	Non-irrigated	Irrigated	Cotton (lint)		Grain sorghum		Cotton (lint)		Grain sorghum	
			A	B	A	B	A	B	A	B
			Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.
Amarillo fine sandy loam, 0 to 1 percent slopes	IIIe-1	IIe-2	145	175	800	1,200	650	850	4,000	7,000
Amarillo fine sandy loam, 1 to 3 percent slopes	IIIe-1	IIIe-2	120	140	600	1,000	550	750	3,000	5,000
Amarillo fine sandy loam, 3 to 5 percent slopes	IVe-1	IVe-1	85	(1/)	300	500	350	(1/)	1,500	3,200
Amarillo loam, 0 to 1 percent slopes	IIIce-1	IIe-1	140	170	800	1,100	650	850	4,000	7,000
Amarillo loam, 1 to 2 percent slopes	IIIe-2	IIIe-1	120	140	600	800	550	750	3,000	5,000
Amarillo loamy fine sand, 0 to 3 percent slopes	IVe-2	IIIe-5	125	155	700	900	525	700	3,000	5,000
Arch fine sandy loam	IVes-1	IIIes-1	85	(1/)	450	560	400	500	1,900	2,400
Arch loam	IVes-1	IIIes-1	85	(1/)	450	560	400	500	1,900	2,400
Arvana fine sandy loam, 0 to 1 percent slopes	IIIe-1	IIe-2	135	160	775	1,050	575	750	3,500	6,000
Arvana fine sandy loam, 1 to 3 percent slopes	IIIe-1	IIIe-2	115	135	580	950	500	650	2,800	4,500
Arvana fine sandy loam, shallow, 0 to 1 percent slopes	IVe-4	IIIe-7	75	115	475	580	370	475	2,300	2,700
Berthoud-Potter complex	VIe-3	(2/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
Bippus and Spur soils	IIIe-1	IIe-2	145	175	900	1,200	650	850	4,000	7,000
Brownfield fine sand, thick surface	VIe-2	IVe-3	80	(1/)	300	(1/)	350	(1/)	1,800	3,500
Brownfield fine sand, thin surface	IVe-3	IIIe-6	105	135	600	800	450	600	2,800	4,500
Brownfield soils, severely eroded	VIe-2	(2/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
Brownfield-Tivoli fine sands	VIIe-1	(2/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
Drake soils, 1 to 3 percent slopes	IVes-1	IIIes-1	65	(1/)	400	500	375	475	1,800	2,300
Drake soils, 3 to 5 percent slopes	VIe-1	IVe-2	50	(1/)	350	(1/)	300	(1/)	900	1,200
Drake soils, 5 to 8 percent slopes	VIe-1	(2/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
Gomez and Portales soils	IVe-2	IVe-3	95	(1/)	525	(1/)	400	(1/)	1,600	3,300
Kimbrough soils	VIIs-1	(2/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
Lubbock clay loam	IIIce-1	IIe-1	140	165	800	1,100	650	850	4,000	7,000
Lubbock fine sandy loam	IIIe-1	IIe-2	145	175	800	1,200	650	850	4,000	7,000
Mansker fine sandy loam, 0 to 1 percent slopes	IVe-4	IIIe-7	75	125	525	630	425	550	2,400	3,000
Mansker fine sandy loam, 1 to 3 percent slopes	IVe-4	IIIe-7	65	120	515	610	400	500	2,350	2,900
Mansker loam, 0 to 1 percent slopes	IVe-4	IIIe-7	80	(1/)	500	600	425	550	2,400	3,000
Mansker loam, 1 to 3 percent slopes	IVe-4	IIIe-7	70	(1/)	500	600	400	500	2,350	2,900
Portales fine sandy loam, 0 to 1 percent slopes	IIIe-3	IIe-4	130	160	750	1,050	550	725	3,500	5,900
Portales fine sandy loam, 1 to 3 percent slopes	IIIe-3	IIIe-4	110	130	575	925	500	625	2,600	4,100
Portales loam, 0 to 1 percent slopes	IIIce-2	IIe-3	135	160	700	900	560	780	3,500	6,000

See footnote at end of table.

TABLE 2.--ESTIMATED AVERAGE ACRE YIELDS, ON NONIRRIGATED AND IRRIGATED SOILS, UNDER TWO LEVELS OF MANAGEMENT--Continued

Soil	Capability unit		Nonirrigated soils				Irrigated soils			
	Non-irrigated	Irrigated	Cotton (lint)		Grain sorghum		Cotton (lint)		Grain sorghum	
			A	B	A	B	A	B	A	B
			Lb	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.
Portales loam, 1 to 3 percent slopes	IIIe-4	IIIe-3	115	135	550	750	500	625	2,700	4,200
Randall fine sandy loam, thick surface variant	IVw-1	IVw-1	145	(1/)	900	1,300	600	(1/)	4,000	7,000
Randall soils	VIw-1	(2/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
Stegall loam, 0 to 1 percent slopes	IIIce-1	IIe-1	140	160	800	1,000	575	800	3,700	6,000
Stegall loam, shallow, 0 to 1 percent slopes	IVe-4	IIIe-7	75	115	475	580	370	475	2,300	2,700
Tivoli fine sand	VIIe-1	(2/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
Tivoli-Potter complex	VIIe-1	(2/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
Zita fine sandy loam, 0 to 1 percent slopes	IIIe-1	IIe-2	145	175	800	1,200	650	850	4,000	7,000
Zita fine sandy loam, 1 to 3 percent slopes	IIIe-1	IIIe-2	120	140	600	1,000	550	750	3,000	5,000
Zita loam, 0 to 1 percent slopes	IIIce-1	IIe-1	140	170	800	1,100	650	850	4,000	7,000

1/ Crop not commonly grown on this soil.

2/ Soil not suitable for irrigation.

actually the cover is weedy and the long-time trend is toward lower production. On the other hand, rangeland that has been closely grazed for relatively short periods, under the supervision of a careful manager, may have a degraded appearance that temporarily conceals its quality and its ability to recover.

Normally, in any given area of range, several range sites are represented, but one will be preferred for grazing. If this preferred site is properly managed, the entire range will improve.

Figure 17.—Irrigated grass grown for seed. Weeping lovegrass in foreground, and sand bluestem in background.

The basic principles of management for maintaining and improving rangeland include (1) selection of the kind of livestock to which the range is best suited, (2) limitation of grazing to protect the plant cover, (3) seasonal adjustment to make best use of seasonally palatable plants and to prevent overuse of any part of the range, and (4) even distribution of stock over the range, to ensure uniform use. Supplemental measures, including deferred grazing, control of brush, control of water, and seeding, may be needed in some places to restore seriously deteriorated areas to good condition.

Descriptions of range sites

In Cochran County, there are seven distinct range sites. The most extensive are the Sandy Land, Deep Sand, and Mixed Land sites. Those of lesser extent are the Shallow Land, Mixed Plains, Deep Hardland, and High Lime sites. Randall soils and Randall fine sandy loam, thick surface variant, have no range site classification. They are considered part of whatever site the surrounding soils are included in.

SANDY LAND SITE

Undulating slopes, hummocks, and subdued dunes characterize this site. There are no long, distinct slopes. The drainage pattern is poorly defined or nonexistent. The soils are highly susceptible to wind erosion unless a good ground cover is maintained. The soils in this site are—

Amarillo loamy fine sand, 0 to 3 percent slopes.
Brownfield fine sand, thin surface.

Gomez and Portales soils.
Tivoli-Potter complex.

The Tivoli-Potter complex has approximately the characteristics of the Sandy Land site, although the Tivoli soils that are mapped separately are in the Deep Sand site and the Potter soils that are included in other mapping units are in the Shallow Land site. The Potter soils in the Tivoli-Potter complex, and also the Mansker and Berthoud soils mapped as part of this complex, are covered with a deposit of sand and consequently are deeper and more productive than the normal soils of those series.

The climax vegetation on this site includes a variety of grasses. Indiangrass, switchgrass, and bluestem, little bluestem, sand lovegrass, side-oats grama, New Mexico feathergrass, and needle-and-thread are decreasers. The increasers are giant dropseed, sand dropseed, blue grama, hairy grama, silver bluestem, perennial three-awn, hooded windmillgrass, sand paspalum, and fall witchgrass. The more common invaders are gummy lovegrass, tumblegrass, red lovegrass, tumble lovegrass, tumble windmillgrass, fringed signalgrass, yucca, sand sagebrush, skunkbush, shin oak, groundsel, queensdelight, western ragweed, and numerous annuals.

Shin oak has spread rapidly from the original motts, or clumps, in the climax vegetation. Sand sagebrush and skunkbush spread fairly rapidly if the range is heavily grazed. All three can be controlled easily by aerial application of chemicals.

Because the tall grasses that dominate on this site decline in nutritive value and in palatability in winter, this site is best suited to spring and summer use.

Preliminary data indicate that the yield of herbage varies from 3,400 pounds per acre in favorable years to 2,500 pounds per acre in less favorable years.

DEEP SAND SITE

Rolling to hilly slopes and bands of dunes characterize this site. The drainage pattern is poorly defined or nonexistent. The soils take in water rapidly. They are highly susceptible to wind erosion. Blowouts form quickly where the vegetation is sparse. The soils in this site are—

Brownfield fine sand, thick surface.
Brownfield soils, severely eroded.
Brownfield-Tivoli fine sands.
Tivoli fine sand.

Indiangrass, sand bluestem, switchgrass, sand lovegrass, big sandreed, New Mexico feathergrass, side-oats grama, and little bluestem are the principal decreasers in the climax vegetation in this site. Important increasers are hairy grama, blue grama, silver bluestem, hooded windmillgrass, and perennial three-awn. Invaders include gummy lovegrass, tumble lovegrass, tumblegrass, red lovegrass, tumble windmillgrass, fringed signalgrass, yucca, sand sagebrush, skunkbush, groundsel, western ragweed, and numerous annuals.

Shin oak, which occurs in small motts, or clumps, in the climax vegetation, spreads rapidly as the grass cover disappears under heavy grazing. Shin oak can be controlled by spraying.

Because the tall grasses that dominate on this site decline in nutritive value and in palatability in winter, this site is best suited to spring and summer use. Preliminary data indicate that the yield of herbage varies from 3,000 pounds per acre in favorable years to 2,200 pounds in unfavorable years.

MIXED LAND SITE

Level to gently sloping plains interspersed with playas make up this site. The slope range is 0 to 5 percent; the gradient is normally less than 3 percent, and the slope is toward playas or shallow draws. The soils in this site are—

Amarillo fine sandy loam, 0 to 1 percent slopes.
Amarillo fine sandy loam, 1 to 3 percent slopes.
Amarillo fine sandy loam, 3 to 5 percent slopes.
Arvana fine sandy loam, 0 to 1 percent slopes.
Arvana fine sandy loam, 1 to 3 percent slopes.
Arvana fine sandy loam, shallow, 0 to 1 percent slopes.
Lubbock fine sandy loam.
Zita fine sandy loam, 0 to 1 percent slopes.
Zita fine sandy loam, 1 to 3 percent slopes.

Bippus soils, mapped only with Spur soils, belong in this site, also.

Mid grasses dominate in the climax vegetation on this site. Blue grama, side-oats grama, Arizona cottontop, and plains bristlegrass are the principal decreasers. The increasers are buffalograss, hooded windmillgrass, sand dropseed, and silver bluestem. Common invaders are hairy tridens, broom snakeweed, catclaw, mesquite, and many annuals.

Heavy grazing has changed the original mixture of grasses in many places. Buffalograss is now dominant on a large part of this site. Enough of the better grasses remains to form an adequate source of seed. Under good management, these better grasses spread and the condition of the site improves.

If kept in good condition, this site can be used at any season of the year. Preliminary data indicate that the yield of herbage varies from 3,000 pounds per acre in favorable years to 2,100 pounds per acre in less favorable years.

DEEP HARDLAND SITE

Level to gently sloping plains interspersed with playas make up this site. The soils in this site are—

Amarillo loam, 0 to 1 percent slopes.
Amarillo loam, 1 to 2 percent slopes.
Lubbock clay loam.
Stegall loam, 0 to 1 percent slopes.
Stegall loam, shallow, 0 to 1 percent slopes.
Zita loam, 0 to 1 percent slopes.

Most of these soils have high fertility and a high water-holding capacity but absorb water slowly. Only short grasses can exist on the small water supply. Consequently, blue grama is the dominant decreaser on this range site. Mid grasses, such as side-oats grama, vine-mesquite, and western wheatgrass, grow in areas that receive extra water from runoff. Buffalograss is the main increaser. Sand muhly, mesquite, and annual weeds are common invaders.

Pitting or chiseling is often used to stimulate the growth of grass in overused stands. Sometimes the survival of the grass depends on the supplemental water held in the playa basins. Maintaining a healthy stand of grass at all times is the best method of improving the condition of the range (fig. 18). Improvement is indicated by an increase in blue grama and a decrease in weeds.

If kept in excellent or good condition, this site can be used at any season of the year. Preliminary data indicate that the yield of herbage on this site varies from 2,800

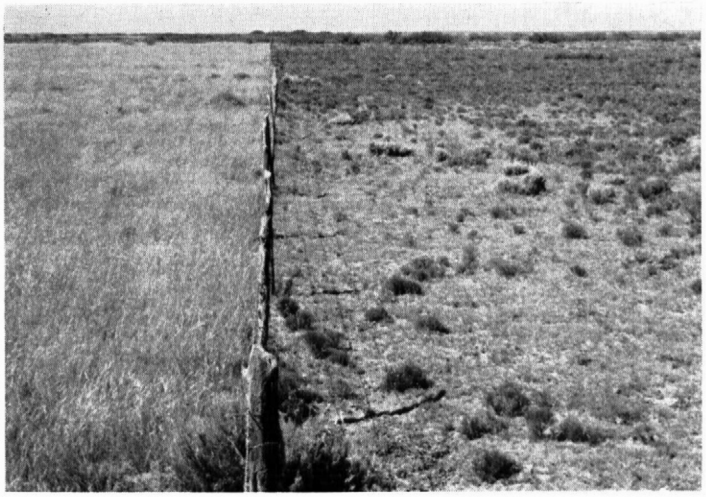

Figure 18.—Fence-line contrast, showing results of deferred grazing in pasture at left. Predominant grass is blue grama.

pounds per acre in favorable years to 1,700 pounds per acre in unfavorable years.

HIGH LIME SITE

This site consists of flats or large sloping dunes on the east side of playas. The soils contain large amounts of free lime. Unless protected by vegetation, they are highly susceptible to wind erosion and, in the sloping areas, to water erosion. The soils in this site are—

Arch fine sandy loam.
Arch loam.
Drake soils, 1 to 3 percent slopes.
Drake soils, 3 to 5 percent slopes.
Drake soils, 5 to 8 percent slopes.

Decreasers in the climax vegetation on this site include blue grama, vine-mesquite, and side-oats grama. Increasers include buffalograss, black grama, and alkali sacaton. Invaders are inland saltgrass, sand muhly, mesquite, and many annuals.

In some parts of this site, the lime content of the soils is so high that nothing grows except such grasses as alkali sacaton and inland saltgrass. Such areas should be managed to increase the production of alkali sacaton.

If kept in excellent or good condition, this site can be used at any season of the year. Preliminary data indicate that the yield of herbage varies from 2,900 pounds per acre in favorable years to 1,700 pounds in less favorable years.

MIXED PLAINS SITE

This site consists of flat to gently sloping plains, mostly next to draws or natural depressions. The soils are highly calcareous, crumbly, and permeable. They are highly susceptible to erosion when the vegetative cover is sparse. The soils in this site are—

Mansker loam, 0 to 1 percent slopes.
Mansker loam, 1 to 3 percent slopes.
Mansker fine sandy loam, 0 to 1 percent slopes.
Mansker fine sandy loam, 1 to 3 percent slopes.
Portales fine sandy loam, 0 to 1 percent slopes.
Portales fine sandy loam, 1 to 3 percent slopes.
Portales loam, 0 to 1 percent slopes.
Portales loam, 1 to 3 percent slopes.

Spur soils, though mapped only with Bippus soils, have characteristics that appropriately place them in this range site. Berthoud soils, mapped only in a complex with Potter soils, also belong in this site.

This site is productive, but under continued heavy grazing the plant community degenerates to buffalograss. The site responds favorably to good range management if enough of the better grasses is left to form seed.

Preliminary data indicate that the yield of herbage varies from 3,200 pounds per acre in favorable years to 2,400 pounds in less favorable years. If kept in excellent or good condition, this site can be used at any season of the year.

SHALLOW LAND SITE

Nearly level to steep slopes, mostly on the rims of basins or draws or above escarpments, characterize this site. The soils are very shallow but are able to use moisture effectively. Gravel and small rocks are embedded in the surface and scattered through the soils. The soils in this site are—

Kimbrough soils.

Potter soils mapped with Berthoud soils belong in this site. Also, some areas of Potter soils mapped as part of the Tivoli-Potter complex have some characteristics that would place them in this site.

Although the soils are very shallow, this site supports a good variety of grasses. It cannot, however, withstand continued heavy use. Side-oats grama, blue grama, and little bluestem are the principal decreasers in the climax vegetation. Because of variations in topography, some areas have more moisture than others. In the places that have more moisture, the decreasers include sand bluestem, switchgrass, Canada wildrye, and New Mexico feathergrass. Increasers include buffalograss, black grama, hairy grama, sand dropseed, and perennial three-awn. Invaders are hairy tridens, red grama, sand muhly, broom snakeweed, mesquite, and annuals. Broom snakeweed readily invades areas that are bare of vegetation. This noxious plant must be controlled by spraying before grass can become reestablished.

If kept in good or excellent condition, this site can be used at any season of the year. Preliminary data indicate that the yield of herbage varies from 2,600 pounds per acre in favorable years to 1,800 pounds per acre in less favorable years.

Engineering Applications [3]

The information in this section will be helpful in planning and making estimates for various engineering construction jobs. It will not eliminate, however, the need for on-site sampling and testing for design and construction of specific engineering works.

Information in this report can be used to—

1. Make soil and land use studies that will aid in the selection and development of industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the soil properties that are significant in the planning of agricultural structures, such as terraces, waterways, irrigation systems, and other soil and water conservation structures.

[3] This section by Y. E. McAdams, area engineer, Soil Conservation Service, Lubbock, Tex.

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3. Make preliminary evaluations of soil and ground conditions that will aid in the selection of highway, airport, and pipeline locations.
4. Locate probable sources of topsoil and of gravel and other construction material for use in structures.
5. Correlate performance of engineering structures with soil mapping units, and thus develop information that will be useful in designing and maintaining the structures.
6. Determine the suitability of soils for the cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps and reports and aerial photographs to make maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction purposes in the particular area.

Some of the terms that are used by soil scientists but that may be unfamiliar to engineers are defined in the Glossary.

Engineering classification systems

Most highway engineers classify soil materials according to the system approved by the American Association of State Highway Officials (*1*). In this system soil materials are classified in seven principal groups. The groups range from A–1, in which are gravelly soils of high bearing capacity, to A–7, which consists of clay soils having low strength when wet.

Some engineers prefer to use the Unified soil classification system (*7*). In this system, soil material is divided into 15 classes, 8 classes for coarse-grained material (GW, GP, GM, GC, SW, SP, SM, SC), 6 for fine-grained material (ML, CL, OL, MH, CH, OH), and 1 for highly organic material (Pt). Mechanical analysis is used to determine the GW, GP, SW, and SP classes of material; mechanical analysis and tests for liquid limit and plasticity index are used to identify GM, GC, SM, SC, and fine-grained soils. The soils of this county are in the SP, SM, SC, ML, CL, and CH classes.

Engineering properties of the soils

Brief descriptions of the soils in Cochran County and estimates of properties that are significant in engineering are given in table 3. Two soil complexes, Brownfield-Tivoli fine sands (Bv), and Tivoli-Potter complex (Tx) are not listed in table 3. The properties of the Brownfield-Tivoli complex can be learned by referring to entries in table 3 for Brownfield fine sand, thick surface, and Tivoli fine sand. The description on page 19 is the best source of information about the Tivoli-Potter complex, which is an intricate mixture of several kinds of soils.

The Unified and AASHO classifications given in table 3 are based on data from field tests and on the soil survey reports for Dawson, Hansford, Lamb, Lynn, and Terry Counties.

Permeability, as shown in table 3, was estimated for the soil material as it occurs without compaction.

The available water capacity, in inches per inch of depth, is an estimate of the amount of capillary water in a soil that is wet to field capacity. When the soil material is air dry, this amount of water will wet it to a depth of 1 inch without deeper percolation.

The shrink-swell potential indicates the volume change of the soil material that can be expected with changes in moisture content. In general, soils classified as CH and A–7 have a high shrink-swell potential. Sands and gravels having small amounts of slightly plastic fines, as well as most other nonplastic to slightly plastic soil materials, have a low shrink-swell potential.

Additional information for the engineering section was based on experience of personnel of the Texas State Highway Department and of local representatives of the Soil Conservation Service.

Engineering interpretations of soil properties

The evaluation of the soils for engineering use is given in table 4. Specific features in the soil profile that may affect engineering work are pointed out. These features are estimated from actual test data available and from field experience in the performance of the soils.

The rating of a soil for road subgrade is based on the estimated classification of the soil materials. In flat terrain, the rating applies to the soil materials in the A and B horizons, and in steeper terrain (slopes of 6 percent or steeper) it applies primarily to the soil materials in the C horizon. Soils that have a plastic clay layer, such as Lubbock clay loam and Randall clay, have impeded internal drainage and have low stability when wet; hence, they are rated poor. Coarser textured and better graded soils are rated fair.

The suitability of a soil for road fill depends largely on its texture and its natural water content. Plastic soils with a high natural water content, such as Lubbock clay loam and Randall clay, are difficult to handle, to compact, and to dry to the desired water content; hence they are rated poor. Very sandy soils are difficult to place and to compact because they do not contain enough binding materials. These are rated poor to fair.

The vertical alinement, or placement of the roadway, is affected by the soil material and by drainage. Cuts made in dune sands, such as Tivoli fine sand, expose highly erodible material to the action of wind and water. Cut slopes in soils that have highly plastic clay layers, such as Lubbock clay loam and Randall clay, should be nearly flat because such soils are susceptible to sloughing and sliding. The presence of a rocklike caliche layer, as in Arvana soils, Kimbrough soils, and Stegall loam, may necessitate the use of special equipment to excavate the material.

The Arvana, Kimbrough, Stegall, and Potter soils are possible sources of hard caliche for use in road construction and surfacing. Bedrock is not likely to be encountered. None of the soils in Cochran County are sources of sand or gravel.

The soils in this county are suited to both surface irrigation and sprinkler irrigation. Sprinkler irrigation may be used on all the soils, and it is the best method for coarse-textured soils, shallow soils, and rolling soils. Fine-textured and medium-textured soils that have nearly level, uniform slopes and are 20 inches or more in depth can be irrigated by surface methods.

Terraces and diversions constructed from coarse-textured soils are difficult to maintain. Wind erosion and water erosion are serious hazards in maintaining terrace ridges and channels at desired specifications.

Waterways in the soils of Cochran County have to be carefully stabilized. On highly erodible soils, accumulations of windblown material in waterways create a difficult maintenance problem.

Dikes and levees are not needed in this county. If needed, they could be constructed on most of the soils that can be terraced.

Farm ponds are not constructed in Cochran County because (1) there is an abundance of underground water, (2) the soils have an excessive seepage hazard, and (3) there is very little drainage or runoff to feed water to ponds.

Winter grading and frost action are not considered problems, because the soils generally have a low moisture content during the winter, and subfreezing temperatures are of fairly short duration.

Formation, Classification, and Morphology of the Soils

This section explains how soils form and the factors that are involved in their formation. It describes briefly the system of soil classification used in the United States, shows how the soils of Cochran County have been classified, and describes the outstanding morphological characteristics of these soils. Technical terms used in this section are defined in the Glossary at the back of this report.

Factors of Soil Formation

Soil is a function of climate, living organisms, parent material, topography, and time. The nature of the soil at any point on the earth depends upon the combination of the five major factors at that point. All five of these factors come into play in the genesis of every soil. The relative importance of each differs from place to place; sometimes one is more important and sometimes another. In extreme cases one factor may dominate in the formation of the soil and fix most of its properties, as is common when the parent material consists of pure quartz sand. Little can happen to quartz sand, and the soils derived from it usually have faint horizons. Even in quartz sand, however, distinct profiles can be formed under certain types of vegetation where the topography is low and flat and the water table is high.

The interrelationships among the factors of soil formation are complex, and the effects of any one factor cannot be isolated and identified with certainty. It is convenient, however, to discuss the factors of soil formation separately and to indicate some of their probable effects. The reader should always remember that the factors interact continually in the processes of soil formation and that the interactions are important to the nature of every soil.

Climate

Precipitation, temperature, humidity, and wind have been important in the development of the soils of Cochran County. During any given geologic period, the climate was uniform throughout the county. The wet and dry climatic cycles of past geologic ages have influenced the deposition of parent materials. Materials laid down by water in wet periods were reworked and mixed by wind during dry periods. Later, as a result of limited rainfall that has seldom wet the soils below the area of living roots, horizons of calcium carbonate formed in most of the zonal and intrazonal soils. Also, as a result of low rainfall, leaching has been limited, and many of the younger soils still have free lime throughout the profile.

Wind is an outstanding factor in the development of soils in this area. It has affected soil development from the time it deposited sands over preexisting alluvial materials in the Illinoian stage of the Pleistocene epoch to the present, when it continues to shift coarse sand on the surface (*6*).

Living organisms

Vegetation, micro-organisms, earthworms, and other forms of life that live on and in the soils contribute to their development. The type and amount of vegetation are important. They are determined partly by the climate and partly by the kind of parent material. Climate limited the vegetation of Cochran County to grass. The parent material determined whether the grass would be tall, as on the sands, or short, as on the clays.

Before settlement of the county, the native vegetation was most important in the complex of living organisms that affect soil development. The mixed prairie type of vegetation contributed large amounts of organic matter to the soil. Decaying grass leaves and stems distributed this organic matter on the soil surface. Decomposition of the fine roots distributed it throughout the solum. The network of tubes and pores left by these decaying roots facilitated the passage of air and water, and the roots themselves provided abundant food for bacteria, actinomycetes, and fungi.

Earthworms are the most noticeable form of animal life in the soil. Despite low rainfall and periods when the entire solum is dry, the importance of earthworms in soil development is easily seen. In some places 30 to 40 percent of the subsoil of Portales and Zita soils is worm casts. Worm casts facilitate the movement of air, water, and plant roots in the soil.

Soil-dwelling rodents have had a part in the development of some soils. Farmers and ranchers who have occupied the land since it was in native grass know where large prairie-dog towns thrived. The burrowing of these animals brought caliche to the surface. Rain dissolved lime from this material and carried it back into the soil. The burrowing destroyed soil structure. Over a period of years, reddish-brown soils were changed to grayish-brown soils. Portales soils within large areas of Amarillo soils furnish a good example of the results of this process. In contrast to the Amarillo soils around them, the Portales soils are calcareous to the surface, have weaker structure in the subsoil, and have weaker Cca horizons in many places.

In the last 35 years, man has become important to the future direction and rate of development of the soils. He has changed the vegetation. By tilling the land, harvesting crops, and allowing runoff and wind erosion, he has reduced the amount of organic matter and of silt

TABLE 3.--BRIEF DESCRIPTIONS OF SOILS, AND ESTIMATED

Map symbol	Soil	Description	Depth from surface	Engineering classification	
				Unified	AASHO
			In.		
AfA AfB AfC	Amarillo fine sandy loam, 0 to 1 percent slopes. Amarillo fine sandy loam, 1 to 3 percent slopes. Amarillo fine sandy loam, 3 to 5 percent slopes.	6 to 12 in. of fine sandy loam over 30 to 50 in. of moderately permeable, well-drained sandy clay loam; developed on unconsolidated, moderately sandy, alluvial and eolian sediments.	0 to 10--- 10 to 27-- 27 to 44-- 44 to 62--	SM-SC------------ SC or CL---------- SC or CL---------- SC or CL----------	A-4--------------- A-6--------------- A-6--------------- A-6---------------
AlA AlB	Amarillo loam, 0 to 1 percent slopes. Amarillo loam, 1 to 2 percent slopes.	6 to 12 in. of loam over 20 to 40 in. of moderately permeable, well-drained sandy clay loam; developed on unconsolidated, moderately sandy, alluvial and eolian sediments.	0 to 8---- 8 to 24--- 24 to 38-- 38 to 54--	SC or CL---------- CL---------------- CL---------------- CL----------------	A-4 or A-6-------- A-6--------------- A-6--------------- A-6---------------
AmB	Amarillo loamy fine sand, 0 to 3 percent slopes.	8 to 16 in. of loamy fine sand over 30 to 50 in. of moderately permeable, well-drained sandy clay loam; developed on unconsolidated, moderately sandy, alluvial and eolian sediments.	0 to 12--- 12 to 30-- 30 to 52-- 52 to 66--	SM---------------- SC or CL---------- SC or CL---------- SC or CL----------	A-2--------------- A-4 or A-6-------- A-4 or A-6-------- A-4 or A-6--------
An	Arch fine sandy loam.	4 to 8 in. of fine sandy loam over 6 to 12 in. of moderately rapidly permeable, well-drained light sandy clay loam or loam; developed on thick beds of soft, chalky, lime-enriched sediments; a very strongly calcareous soil.	0 to 6---- 6 to 15--- 15 to 42--	SM-SC------------ SC or CL---------- CL----------------	A-4--------------- A-6--------------- A-6---------------
Ao	Arch loam.	4 to 8 in. of loam over 6 to 12 in. of loam or clay loam; developed on thick beds of soft, chalky, lime-enriched sediments; a very strongly calcareous soil.	0 to 6---- 6 to 15--- 15 to 42--	CL----------- CL----------- CL-----------	A-6---------------- A-6---------------- A-6----------------

PHYSICAL PROPERTIES SIGNIFICANT IN ENGINEERING

USDA texture	Percentage passing sieve-- No. 4	No. 10	No. 200	Permeability of entire profile	Available water	Reaction	Shrink-swell potential
				In. per hr.	In. per in. of depth	pH	
Fine sandy loam----	100--------	100--------	40 to 50--	0.75 to 2.0--	0.125	6.7 to 7.8--	Low.
Sandy clay loam----	100--------	100--------	45 to 60--	-------------	.150	7.0 to 7.8--	Moderate.
Sandy clay loam----	95 to 100--	95 to 100--	45 to 60--	-------------	.133	7.5 to 8.0--	Moderate.
Sandy clay loam----	75 to 95---	75 to 95---	45 to 60--	-------------	.125	8.0 to 8.5--	Moderate.
Loam---------------	100--------	100--------	45 to 65--	0.5 to 1.5---	.150	6.8 to 7.8--	Low.
Sandy clay loam----	100--------	100--------	65 to 75--	-------------	.150	6.8 to 7.5--	Moderate.
Sandy clay loam----	100--------	100--------	55 to 65--	-------------	.133	7.5 to 8.0--	Moderate.
Sandy clay loam----	80 to 95---	80 to 95---	60 to 75--	-------------	.125	8.0 to 8.5--	Moderate.
Loamy fine sand----	100--------	100--------	15 to 20--	1.0 to 2.0---	.083	6.8 to 7.5--	Low.
Sandy clay loam----	100--------	100--------	35 to 55--	-------------	.125	7.0 to 7.8--	Moderate.
Sandy clay loam----	100--------	100--------	35 to 50--	-------------	.125	7.2 to 8.0--	Moderate.
Sandy clay loam----	85 to 95---	80 to 95---	35 to 55--	-------------	.100	8.0 to 8.5--	Moderate.
Fine sandy loam----	99 to 100--	99 to 100--	40 to 50--	1.0 to 2.5---	.125	8.0 to 8.5--	Low.
Sandy clay loam----	99 to 100--	99 to 100--	45 to 65--	-------------	.133	8.0 to 8.5--	Moderate.
Clay loam----------	95 to 100--	95 to 100--	50 to 65--	-------------	.125	8.0 to 8.5--	Moderate.
Loam---------------	99 to 100--	99 to 100--	55 to 65--	0.75 to 2.0--	.150	8.0 to 8.5--	Moderate.
Clay loam----------	99 to 100--	99 to 100--	60 to 70--	-------------	.150	8.0 to 8.5--	Moderate.
Clay loam----------	95 to 100--	95 to 100--	60 to 70--	-------------	.125	8.0 to 8.5--	Moderate.

TABLE 3.--BRIEF DESCRIPTIONS OF SOILS, AND ESTIMATED

Map symbol	Soil	Description	Depth from surface	Engineering classification	
				Unified	AASHO
			In.		
AvA AvB	Arvana fine sandy loam, 0 to 1 percent slopes. Arvana fine sandy loam, 1 to 3 percent slopes.	6 to 10 in. of fine sandy loam over 10 to 30 in. of moderately permeable, well-drained sandy clay loam; developed on hard, rocklike caliche.	0 to 8---- 8 to 30--- 30+-------	SM-SC------------ SC or CL--------- -----------------	A-4-------------- A-6-------------- -----------------
AwA	Arvana fine sandy loam, shallow, 0 to 1 percent slopes.	6 to 10 in. of fine sandy loam over 6 to 10 in. of moderately permeable, well-drained sandy clay loam; developed on hard rocklike caliche.	0 to 8---- 8 to 18--- 18+-------	SM-SC------------ SC or CL--------- -----------------	A-4-------------- A-6-------------- -----------------
Be	Berthoud fine sandy loam. (Berthoud member of Berthoud-Potter complex)	6 to 15 in. of fine sandy loam over several feet of moderately repidly permeable, well-drained sandy clay loam; developed on unconsolidated, moderately sandy local alluvium.	0 to 9---- 9 to 18--- 18 to 65--	SM-SC------------ SC or CL--------- SC or CL---------	A-4-------------- A-4 or A-6------- A-4 or A-6-------
Bp	Bippus soils. (Bippus member of Bippus and Spur soils)	4 to 15 in. of fine sandy loam over several feet of moderately permeable, well-drained sandy clay loam; developed on unconsolidated, moderately sandy local alluvium.	0 to 8---- 8 to 30--- 30 to 66--	SM-SC------------ SC or CL--------- SC or CL---------	A-4-------------- A-4 or A-6------- A-4 or A-6-------
Br	Brownfield fine sand, thick surface.	18 to 36 in. of fine sand over several feet of moderately permeable, well-drained sandy clay loam; developed from unconsolidated eolian materials.	0 to 24--- 24 to 60-- 60 to 80--	SP-SM------------ SC--------------- SC---------------	A-2-------------- A-2, A-4, or A-6-- A-2, A-4, or A-6--
Bs Bt3	Brownfield fine sand, thin surface. Brownfield soils, severely eroded.	8 to 18 in. of fine sand over several feet of moderately permeable, well-drained sandy clay loam; developed from unconsolidated eolian materials.	0 to 14--- 14 to 60-- 60 to 80--	SP-SM or SM------- SC--------------- SC---------------	A-2-------------- A-2, A-4, or A-6-- A-2, A-4, or A-6--

PHYSICAL PROPERTIES SIGNIFICANT IN ENGINEERING--Continued

USDA texture	Percentage passing sieve-- No. 4	No. 10	No. 200	Permeability of entire profile	Available water	Reaction	Shrink-swell potential
				In. per hr.	In. per in. of depth		
Fine sandy loam----	100--------	100--------	40 to 50--	0.75 to 2.0--	0.125	6.7 to 7.8--	Low.
Sandy clay loam----	100--------	100--------	45 to 60--	-------------	.142	7.0 to 7.8--	Moderate.
Indurated caliche--	-----------	-----------	----------	-------------	-----	------------	
Fine sandy loam----	100--------	100--------	40 to 50--	0.75 to 2.0--	.125	6.8 to 7.5--	Low.
Sandy clay loam----	100--------	100--------	45 to 60--	-------------	.142	7.0 to 7.5--	Moderate.
Indurated caliche--	-----------	-----------	----------	-------------	-----	------------	
Fine sandy loam----	98 to 100--	98 to 100--	40 to 50--	1.5 to 3.0---	.133	7.8 to 8.3--	Low.
Sandy clay loam----	95 to 100--	90 to 100--	40 to 55--	-------------	.142	7.8 to 8.3--	Moderate.
Sandy clay loam----	95 to 100--	90 to 100--	45 to 55--	-------------	.142	7.8 to 8.3--	Moderate.
Fine sandy loam----	98 to 100--	98 to 100--	40 to 50--	1.2 to 2.5---	.125	7.2 to 7.8--	Low.
Sandy clay loam----	98 to 100--	98 to 100--	40 to 55--	-------------	.133	7.2 to 7.8--	Moderate.
Sandy clay loam----	98 to 100--	95 to 100--	40 to 55--	-------------	.125	8.0 to 8.4--	Moderate.
Fine sand----------	100--------	100--------	5 to 10---	1.5 to 3.0---	.067	6.5 to 7.2--	Low.
Sandy clay loam----	100--------	100--------	30 to 45--	-------------	.125	6.8 to 7.2--	Moderate.
Sandy clay loam----	100--------	100--------	25 to 35--	-------------	.100	7.0 to 7.5--	Moderate.
Fine sand----------	100--------	100--------	5 to 15---	1.5 to 3.0---	.067	6.5 to 7.2--	Low.
Sandy clay loam----	100--------	100--------	30 to 50--	-------------	.125	6.8 to 7.2--	Moderate.
Sandy clay loam----	100--------	100--------	25 to 40--	-------------	.100	7.0 to 7.5--	Moderate.

TABLE 3.--BRIEF DESCRIPTIONS OF SOILS, AND ESTIMATED

Map symbol	Soil	Description	Depth from surface	Engineering classification	
				Unified	AASHO
			In.		
DrB DrC DrD	Drake soils, 1 to 3 percent slopes. Drake soils, 3 to 5 percent slopes. Drake soils, 5 to 8 percent slopes.	4 to 12 in. of fine sandy loam over several feet of very strongly calcareous loam; developed in wind-deposited dunes to the east of playas.	0 to 6---- 6 to 13--- 13 to 48--	SM-SC------------ CL--------------- CL---------------	A-4-------------- A-4 or A-6-------- A-4 or A-6--------
Go	Gomez soils. (Gomez member of Gomez and Portales soils)	10 to 30 in. of loamy fine sand over 8 to 20 in. of fine sandy loam; developed in unconsolidated, sandy, calcareous sediments.	0 to 18--- 18 to 30-- 30 to 44-- 44 to 72--	SM--------------- SM-SC------------ SM-SC------------ SM---------------	A-2-------------- A-2 or A-4-------- A-2 or A-4-------- A-2--------------
Km	Kimbrough soils.	2 to 10 in. of loam over thick beds of stonelike caliche.	0 to 6---- 6+--------	SM-SC, ML, or CL-- -----------------	A-4 or A-6-------- -----------------
Lv	Lubbock clay loam.	14 to 26 in. of clay loam over 15 to 30 in. of slowly permeable, compact clay that grades to calcareous clay loam; developed from unconsolidated clay loam in slight depressions.	0 to 18--- 18 to 42-- 42 to 70--	CL--------------- CL or CH--------- CL---------------	A-6-------------- A-6 or A-7-6------ A-6--------------
Lu	Lubbock fine sandy loam.	8 to 14 in. of fine sandy loam over 6 to 12 in. of clay loam over 8 to 14 in. of slowly permeable, compact clay that grades to calcareous clay loam; developed from unconsolidated clay loam.	0 to 10--- 10 to 20-- 20 to 32-- 32 to 74--	SM-SC------------ CL--------------- CL or CH--------- CL---------------	A-4-------------- A-6-------------- A-6 or A-7-6------ A-6--------------
MfA MfB	Mansker fine sandy loam, 0 to 1 percent slopes. Mansker fine sandy loam, 1 to 3 percent slopes.	6 to 10 in. of fine sandy loam over 6 to 12 in. of sandy clay loam; developed from unconsolidated, strongly calcareous, medium-textured to moderately fine textured sediments.	0 to 6---- 6 to 15--- 15 to 48--	SM-SC------------ CL--------------- CL---------------	A-4-------------- A-4 or A-6-------- A-4 or A-6--------

PHYSICAL PROPERTIES SIGNIFICANT IN ENGINEERING--Continued

USDA texture	Percentage passing sieve-- No. 4	No. 10	No. 200	Permeability of entire profile	Available water	Reaction	Shrink-swell potential
				In. per hr.	In. per in. of depth	pH	
Fine sandy loam----	100--------	100--------	40 to 50--	1.0 to 3.0--	0.125	8.0 to 8.5--	Low.
Loam---------------	100--------	100--------	40 to 55--	------------	.133	8.0 to 8.5--	Low.
Loam---------------	100--------	100--------	40 to 60--	------------	.083	8.0 to 8.5--	Low.
Loamy fine sand----	98 to 100--	98 to 100--	10 to 20--	1.5 to 3.0---	.083	7.6 to 8.2--	Low.
Fine sandy loam----	98 to 100--	98 to 100--	20 to 40--	-------------	.125	7.8 to 8.3--	Low.
Fine sandy loam----	95 to 100--	95 to 100--	20 to 40--	-------------	.083	8.0 to 8.5--	Low.
Loamy fine sand----	98 to 100--	98 to 100--	10 to 20--	-------------	.067	8.0 to 8.3--	Low.
Loam---------------	98 to 100--	98 to 100--	40 to 55--	0.75 to 1.5--	.083	7.5 to 8.2--	Low.
Indurated caliche--	-----------	-----------	----------	-------------	-----	------------	
Clay loam----------	100--------	100--------	50 to 75--	0.5 to 1.0---	.167	6.8 to 7.5--	Moderate.
Clay---------------	100--------	100--------	60 to 85--	-------------	.200	7.0 to 7.8--	High.
Clay loam----------	95 to 100--	95 to 100--	50 to 75--	-------------	.150	8.0 to 8.5--	Moderate.
Fine sandy loam----	100--------	100--------	40 to 50--	0.6 to 1.2---	.133	6.8 to 7.5--	Low.
Clay loam----------	100--------	100--------	50 to 70--	-------------	.167	7.0 to 7.5--	Moderate.
Clay---------------	100--------	100--------	60 to 80--	-------------	.200	7.0 to 7.8--	High.
Clay loam----------	95 to 100--	95 to 100--	50 to 70--	-------------	.150	8.0 to 8.5--	Moderate.
Fine sandy loam----	95 to 100--	95 to 100--	40 to 50--	1.5 to 3.0---	.125	8.0 to 8.3--	Low.
Sandy clay loam----	95 to 100--	95 to 100--	50 to 60--	-------------	.150	8.0 to 8.3--	Low to moderate.
Clay loam----------	95 to 100--	95 to 100--	50 to 60--	-------------	.067	8.0 to 8.5--	Moderate.

TABLE 3.--BRIEF DESCRIPTIONS OF SOILS, AND ESTIMATED

Map symbol	Soil	Description	Depth from surface	Engineering classification	
				Unified	AASHO
			In.		
MkA MkB	Mansker loam, 0 to 1 percent slopes. Mansker loam, 1 to 3 percent slopes.	6 to 10 in. of loam over 6 to 12 in. of clay loam; developed from unconsolidated, strongly calcareous, medium-textured to moderately fine textured sediments.	0 to 6---- 6 to 15--- 15 to 48--	CL---------------- CL---------------- CL----------------	A-6--------------- A-6--------------- A-6---------------
PfA PfB	Portales fine sandy loam, 0 to 1 percent slopes. Portales fine sandy loam, 1 to 3 percent slopes.	6 to 10 in. of fine sandy loam over 15 to 30 in. of sandy clay loam; well-drained, calcareous soil; developed on soft, chalky, clay loam caliche.	0 to 8---- 8 to 28--- 28 to 60--	SM-SC------------- SC or CL---------- CL----------------	A-4--------------- A-6--------------- A-6---------------
PmA PmB	Portales loam, 0 to 1 percent slopes. Portales loam, 1 to 3 percent slopes.	6 to 10 in. of loam over 15 to 30 in. of clay loam; well-drained, calcareous soil; developed on soft, chalky, clay loam caliche.	0 to 8---- 8 to 28--- 28 to 60--	CL---------------- CL---------------- CL----------------	A-6--------------- A-6--------------- A-6---------------
Go	Portales loamy fine sand. (Portales member of Gomez and Portales soils)	8 to 15 in. of loamy fine sand over 6 to 10 in. of fine sandy loam over 15 to 30 in. of sandy clay loam; well-drained, calcareous soil; developed on soft, chalky, clay loam caliche.	0 to 10--- 10 to 20-- 20 to 35-- 35 to 60--	SM or SM-SC------- SM-SC------------- SC or CL---------- CL----------------	A-2 or A-4-------- A-4--------------- A-6--------------- A-6---------------
Be	Potter soils. (Potter member of Berthoud-Potter complex)	2 to 10 in. of fine sandy loam over soft to slightly cemented caliche several feet thick.	0 to 8---- 8 to 40---	SM-SC, ML, or CL-- ML or CL----------	A-4 or A-6-------- A-4 or A-6--------
Ra	Randall soils.	10 to 30 in. of blocky clay over massive gray clay, in playas; flooded occasionally.	0 to 25--- 25 to 60--	CL or CH---------- CL or CH----------	A-7-6------------- A-7-6-------------
Rf	Randall fine sandy loam, thick surface variant.	10 to 30 in. of fine sandy loam grading through a sandy clay loam layer to gray clay, in playas; flooded occasionally.	0 to 12--- 12 to 18-- 18 to 60--	SM-SC------------- CL---------------- CL or CH----------	A-4--------------- A-6--------------- A-6 or A-7-6------

PHYSICAL PROPERTIES SIGNIFICANT IN ENGINEERING--Continued

USDA texture	Percentage passing sieve-- No. 4	No. 10	No. 200	Permeability of entire profile	Available water	Reaction	Shrink-swell potential
				In. per hr.	In. per in. of depth	pH	
Loam----------------	95 to 100--	90 to 100--	50 to 60--	1.0 to 2.0---	0.167	8.0 to 8.3--	Moderate.
Clay loam----------	95 to 100--	95 to 100--	55 to 65--	-------------	.167	8.0 to 8.3--	Moderate.
Clay loam----------	95 to 100--	95 to 100--	55 to 65--	-------------	.083	8.0 to 8.5--	Moderate.
Fine sandy loam----	98 to 100--	98 to 100--	40 to 50--	1.5 to 3.0---	.125	7.8 to 8.2--	Low.
Sandy clay loam----	98 to 100--	98 to 100--	45 to 60--	-------------	.142	8.0 to 8.3--	Moderate.
Clay loam----------	95 to 100--	85 to 95---	50 to 60--	-------------	.100	8.0 to 8.5--	Moderate.
Loam----------------	98 to 100--	98 to 100--	50 to 60--	1.0 to 2.0---	.150	7.8 to 8.2--	Moderate.
Clay loam----------	98 to 100--	98 to 100--	55 to 65--	-------------	.150	8.0 to 8.3--	Moderate.
Clay loam----------	95 to 100--	90 to 95---	55 to 65--	-------------	.100	8.0 to 8.5--	Moderate.
Loamy fine sand----	100--------	100--------	20 to 40--	1.5 to 3.0---	.083	7.8 to 8.2--	Low.
Fine sandy loam----	100--------	100--------	30 to 50--	-------------	.125	7.8 to 8.2--	Low.
Sandy clay loam----	98 to 100--	98 to 100--	45 to 60--	-------------	.142	8.0 to 8.3--	Moderate.
Clay loam----------	95 to 100--	95 to 100--	50 to 60--	-------------	.100	8.0 to 8.5--	Moderate.
Fine sandy loam----	90 to 100--	85 to 95---	40 to 55--	1.0 to 2.0---	.125	8.0 to 8.5--	Low.
Loam----------------	85 to 95---	85 to 95---	50 to 60--	-------------	.083	8.0 to 8.5--	Low to moderate
Clay----------------	100--------	100-------	60 to 70--	0.02 to 0.2--	.200	6.8 to 8.0--	High.
Clay----------------	100--------	100-------	75 to 90--	-------------	.200	6.8 to 8.0--	High.
Fine sandy loam----	100--------	100--------	40 to 50--	0.2 to 0.8---	.125	6.8 to 7.5--	Low.
Sandy clay loam----	100--------	100--------	50 to 65--	-------------	.150	6.8 to 7.5--	Moderate.
Clay----------------	100--------	100--------	70 to 90--	-------------	.183	6.8 to 8.0--	High.

TABLE 3.--BRIEF DESCRIPTIONS OF SOILS, AND ESTIMATED

Map symbol	Soil	Description	Depth from surface	Engineering classification	
				Unified	AASHO
			In.		
Bp	Spur soils. (Spur member of Bippus and Spur soils)	10 to 25 in. of fine sandy loam over several feet of sandy clay loam; local alluvium in bottom of draws.	0 to 15--- 15 to 60--	SM-SC------------- SC or CL----------	A-4--------------- A-6---------------
StA	Stegall loam, 0 to 1 percent slopes.	4 to 10 in. of loam over 10 to 30 in. of compact, well-drained, slowly permeable clay loam; developed over rocklike caliche.	0 to 7---- 7 to 26--- 26+-------	CL---------------- CL---------------- ------------------	A-6--------------- A-6--------------- ------------------
SwA	Stegall loam, shallow, 0 to 1 percent slopes.	4 to 10 in. of loam over 6 to 14 in. of compact, well-drained, slowly permeable clay loam; developed over rocklike caliche.	0 to 7---- 7 to 16--- 16+-------	CL---------------- CL---------------- ------------------	A-6--------------- A-6--------------- ------------------
Tv	Tivoli fine sand.	Several feet of fine sand in dunes.	0 to 72---	SP-SM--------------	A-3---------------
ZfA ZfB	Zita fine sandy loam, 0 to 1 percent slopes. Zita fine sandy loam, 1 to 3 percent slopes.	6 to 12 in. of fine sandy loam over 6 to 14 in. of sandy clay loam that grades to soft, chalky, clay loam caliche at depths of 24 to 36 in.; well drained.	0 to 10--- 10 to 20-- 20 to 26-- 26 to 44--	SM-SC or SC------- CL---------------- CL---------------- CL----------------	A-4 or A-6-------- A-6--------------- A-6--------------- A-6---------------
ZmA	Zita loam, 0 to 1 percent slopes.	6 to 12 in. of loam over 6 to 14 in. of clay loam that grades to soft, chalky, clay loam caliche at a depth of 24 to 36 in.; well drained.	0 to 8---- 8 to 20--- 20 to 28-- 28 to 42--	CL---------------- CL---------------- CL---------------- CL----------------	A-6--------------- A-6--------------- A-6--------------- A-6---------------

PHYSICAL PROPERTIES SIGNIFICANT IN ENGINEERING--Continued

USDA texture	Percentage passing sieve-- No. 4	No. 10	No. 200	Permeability of entire profile	Available water	Reaction	Shrink-swell potential
				In. per hr.	In. per in. of depth	pH	
Fine sandy loam----	100--------	100--------	40 to 50--	1.0 to 2.5---	0.125	7.8 to 8.2--	Low.
Sandy clay loam----	100--------	100--------	50 to 60--	-------------	.142	7.8 to 8.2--	Moderate.
Loam---------------	100--------	100--------	50 to 65--	0.5 to 1.0---	.167	7.2 to 7.8--	Moderate.
Clay loam----------	100--------	100--------	60 to 70--	-------------	.183	7.2 to 7.8--	Moderate.
Indurated caliche--	-----------	-----------	----------	-------------	-----	------------	
Loam---------------	100--------	100--------	50 to 65--	0.5 to 1.0---	.167	7.2 to 7.8--	Moderate.
Clay loam----------	100--------	100--------	60 to 70--	-------------	.183	7.2 to 7.8--	Moderate.
Indurated caliche--	-----------	-----------	----------	-------------	-----	------------	
Fine sand----------	100--------	99 to 100--	2 to 6----	1.0 to 4.0---	.067	6.5 to 7.5--	Low.
Fine sandy loam----	100--------	100--------	40 to 50--	1.0 to 2.5---	.133	7.5 to 8.0--	Low.
Sandy clay loam----	100--------	100--------	50 to 60--	-------------	.150	7.5 to 7.8--	Moderate.
Clay loam----------	100--------	100--------	50 to 65--	-------------	.125	7.8 to 8.2--	Moderate.
Clay loam----------	95 to 100--	90 to 100--	50 to 60--	-------------	.083	8.0 to 8.5--	Moderate.
Loam---------------	100--------	100--------	55 to 65--	1.0 to 2.0---	.167	7.5 to 8.0--	Moderate.
Clay loam----------	100--------	100--------	55 to 65--	-------------	.167	7.5 to 7.8--	Moderate.
Clay loam----------	100--------	100--------	55 to 65--	-------------	.150	7.8 to 8.2--	Moderate.
Clay loam----------	95 to 100--	95 to 100--	50 to 60--	-------------	.083	8.0 to 8.5--	Moderate.

TABLE 4.--ENGINEERING

Map symbol	Soil	Suitability of soil for--				
		Road subgrade	Road fill	Topsoil	Location of highways	
					Materials	Drainage
AfA AfB AfC	Amarillo fine sandy loam, 0 to 1 percent slopes. Amarillo fine sandy loam, 1 to 3 percent slopes. Amarillo fine sandy loam, 3 to 5 percent slopes.	Poor to fair--	Fair----------	Fair----------	Fair----------	Good-----
AlA AlB	Amarillo loam, 0 to 1 percent slopes. Amarillo loam, 1 to 2 percent slopes.	Poor----------	Poor to fair--	Fair to good--	Poor to fair--	Fair-----
AmB	Amarillo loamy fine sand, 0 to 3 percent slopes.	Fair----------	Fair----------	Poor to fair--	Fair----------	Good-----
An	Arch fine sandy loam.	Poor to fair--	Fair----------	Poor----------	Poor to fair--	Good-----
Ao	Arch loam.	Poor----------	Poor to fair--	Poor----------	Poor----------	Fair-----
AvA AvB	Arvana fine sandy loam, 0 to 1 percent slopes. Arvana fine sandy loam, 1 to 3 percent slopes.	Poor to fair--	Fair----------	Fair----------	Poor to fair--	Good-----
AwA	Arvana fine sandy loam, shallow, 0 to 1 percent slopes.	Poor to fair--	Fair----------	Fair----------	Poor to fair--	Good-----
Be	Berthoud-Potter complex.	Poor to fair--	Fair----------	Poor to fair--	Fair----------	Good-----

INTERPRETATIONS OF THE SOILS

Soil characteristics affecting--				
Irrigation	Land leveling	Field terraces and diversion terraces	Waterways	Remarks
Moderately high water-holding capacity; high intake rate; high seepage loss in earthen ditches; suited to surface or sprinkler irrigation.	Soil properties favorable; leveling not practical on slopes of more than 3 percent.	Soil properties favorable; no limitations.	Moderately erodible.	Strongly calcareous substrata.
High water-holding capacity; moderate intake rate; moderate seepage loss in earthen ditches; suited to surface or sprinkler irrigation.	Soil properties favorable; no limitations.	Soil properties favorable; no limitations.	Moderately erodible.	Strongly calcareous substrata.
Moderately high water-holding capacity; very high intake rate; excessive seepage loss in earthen ditches; best suited to sprinkler irrigation.	Sandy surface layer creates maintenance problem.	Sandy surface layer creates maintenance problem; gently undulating topography.	Highly erodible; difficult to establish vegetation.	Strongly calcareous substrata.
Low water-holding capacity; very high intake rate; excessive seepage loss in earthen ditches; best suited to sprinkler irrigation.	Lime content limits cuts and increases maintenance problem.	Lime content increases maintenance problem.	Highly erodible; high lime content; difficult to establish vegetation.	Strongly calcareous throughout.
Low water-holding capacity; high intake rate; high seepage loss in earthen ditches; best suited to sprinkler irrigation.	Lime content limits cuts and increases maintenance problem.	Lime content increases maintenance problem.	Highly erodible; high lime content; difficult to establish vegetation.	Strongly calcareous throughout.
Moderate water-holding capacity; high intake rate; high seepage loss in earthen ditches; suited to sprinkler or surface irrigation.	Hard caliche limits cuts.	Hard caliche at depth of 20 to 36 inches.	Hard caliche at depth of 20 to 36 inches.	Rocklike caliche at depth of 20 to 36 inches.
Low water-holding capacity; high intake rate; best suited to sprinkler irrigation.	Shallow; leveling not practical.	Hard caliche at depth of 10 to 20 inches.	Hard caliche at depth of 10 to 20 inches.	Rocklike caliche at depth of 10 to 20 inches.
Steep slopes and very shallow areas; unsuited to irrigation.	Steep slopes and very shallow areas; unsuited to leveling.	Short, steep slopes and very shallow areas; unsuited to terracing.	Steep slopes and shallow areas.	Occurs on short, steep slopes along draws.

TABLE 4.--ENGINEERING

Map symbol	Soil	Suitability of soil for--				
		Road subgrade	Road fill	Topsoil	Location of highways	
					Materials	Drainage
Bp	Bippus and Spur soils.	Poor to fair--	Fair----------	Fair----------	Fair----------	Good-----
Br	Brownfield fine sand, thick surface.	Fair----------	Fair----------	Poor----------	Poor to fair--	Good-----
Bs Bt3	Brownfield fine sand, thin surface. Brownfield soils, severely eroded.	Fair----------	Fair----------	Poor----------	Poor to fair--	Good-----
DrB DrC DrD	Drake soils, 1 to 3 percent slopes. Drake soils, 3 to 5 percent slopes. Drake soils, 5 to 8 percent slopes.	Poor to fair--	Poor to fair--	Poor----------	Poor----------	Good-----
Go	Gomez and Portales soils.	Fair----------	Poor to fair--	Poor----------	Poor----------	Good-----
Km	Kimbrough soils.	Fair to good--	Fair----------	Fair----------	Poor to fair--	Good-----
Lv	Lubbock clay loam.	Poor----------	Poor---------	Poor to fair--	Poor to fair--	Poor-----
Lu	Lubbock fine sandy loam.	Poor to fair--	Fair----------	Fair to good--	Poor to fair--	Poor-----

INTERPRETATIONS OF THE SOILS--Continued

Soil characteristics affecting--				
Irrigation	Land leveling	Field terraces and diversion terraces	Waterways	Remarks
Moderately high water-holding capacity; high intake rate; high seepage loss in earthen ditches; suited to sprinkler or surface irrigation.	Soil properties favorable; no limitations.	Not needed---------	Low position------	Occurs in bottom of draws.
Low water-holding capacity; very high intake rate; undulating topography; suited to sprinkler irrigation.	Very sandy surface layer.	Very sandy surface layer; undulating topography.	Deep sand surface layer; unsuitable for waterways.	Uppermost $1\frac{1}{2}$ to 3 feet very sandy; topography undulating.
Moderate water-holding capacity; very high intake rate; undulating topography; suited to sprinkler irrigation.	Very sandy surface layer.	Very sandy surface layer; undulating topography.	Sandy surface layer and undulating topography; unsuitable for waterways.	Sandy surface layer; undulating topography. Eroded phase has exposed subsoil in some places and sand accumulations in others.
Low water-holding capacity; high intake rate; steep slopes; suited to sprinkler irrigation.	Lime content limits cuts; leveling not practical on slopes of more than 3 percent.	Lime content increases maintenance problem; terracing not practical on steep slopes.	Steep; highly erodible; unsuitable for waterways.	Strongly calcareous.
Low water-holding capacity; very high intake rate; suited to sprinkler irrigation.	Very sandy surface layer.	Very sandy surface layer.	Very sandy; unsuitable for waterways.	Very sandy; strongly calcareous substrata.
Very shallow; unsuited to irrigation.	Very shallow; unsuited to leveling.	Very shallow; unsuited to terracing.	Very shallow; unsuitable for waterways.	Rocklike caliche at depth of less than 10 inches.
High water-holding capacity; low intake rate; suited to surface or sprinkler irrigation.	Soil properties favorable; no limitations.	Not needed---------	Low position------	Occurs in slight depressions; subsoil is highly plastic clay.
High water-holding capacity; low intake rate; suited to surface or sprinkler irrigation.	Soil properties favorable; no limitations.	Not needed---------	Low position------	Occurs in slight depressions; subsoil is highly plastic clay.

TABLE 4.--ENGINEERING

Map symbol	Soil	Suitability of soil for-- Road subgrade	Road fill	Topsoil	Location of highways Materials	Drainage
MfA MfB	Mansker fine sandy loam, 0 to 1 percent slopes. Mansker fine sandy loam, 1 to 3 percent slopes.	Poor to fair--	Fair----------	Poor----------	Fair----------	Good-----
MkA MkB	Mansker loam, 0 to 1 percent slopes. Mansker loam, 1 to 3 percent slopes.	Poor to fair--	Fair----------	Poor to fair--	Fair----------	Good-----
PfA PfB	Portales fine sandy loam, 0 to 1 percent slopes. Portales fine sandy loam, 1 to 3 percent slopes.	Poor to fair--	Fair----------	Fair----------	Fair----------	Good-----
PmA PmB	Portales loam, 0 to 1 percent slopes. Portales loam, 1 to 3 percent slopes.	Poor to fair--	Fair----------	Fair----------	Fair----------	Good-----
Ra	Randall soils.	Poor----------	Poor----------	Poor----------	Poor----------	Poor-----
Rf	Randall fine sandy loam, thick surface variant.	Poor----------	Poor to fair--	Fair----------	Poor to fair--	Poor-----
StA	Stegall loam, 0 to 1 percent slopes.	Poor----------	Fair----------	Fair to good--	Poor to fair--	Poor-----
SwA	Stegall loam, shallow, 0 to 1 percent slopes.	Poor----------	Fair----------	Fair to good--	Poor to fair--	Poor-----
Tv Bv Tx	Tivoli fine sand. Brownfield-Tivoli fine sands. Tivoli-Potter complex.	Poor; good if confined.	Poor to fair--	Unsuitable----	Poor; erodible.	Good-----

INTERPRETATIONS OF THE SOILS--Continued

Soil characteristics affecting--				
Irrigation	Land leveling	Field terraces and diversion terraces	Waterways	Remarks
Low water-holding capacity; high intake rate; best suited to sprinkler irrigation.	Shallow; cuts limited.	Shallow------------	Shallow; difficult to establish vegetation.	Strongly calcareous throughout.
Low water-holding capacity; high intake rate; best suited to sprinkler irrigation.	Shallow; cuts limited.	Shallow------------	Shallow; difficult to establish vegetation.	Strongly calcareous throughout.
Moderate water-holding capacity; high intake rate; best suited to sprinkler irrigation.	Soil properties favorable; no limitations.	Soil properties favorable; no limitations.	Highly erodible; difficult to establish vegetation.	Calcareous throughout.
Moderate water-holding capacity; high intake rate; suited to surface or sprinkler irrigation.	Soil properties favorable; no limitations.	Soil properties favorable; no limitations.	Highly erodible; difficult to establish vegetation.	Calcareous throughout.
High water-holding capacity; very low intake rate; suited to surface irrigation if outside water is controlled.	Outside water and highly plastic clays create maintenance problem.	Not needed---------	Low position------	Occurs in playas; highly plastic clay.
High water-holding capacity; very low intake rate; suited to surface or sprinkler irrigation.	Outside water and highly plastic clay subsoils create maintenance problem.	Not needed---------	Low position------	Occurs in playas; highly plastic clay subsoil.
High water-holding capacity; low intake rate; suited to surface or sprinkler irrigation.	Hard caliche limits cuts.	Hard caliche at depth of 20 to 36 inches.	Hard caliche at depth of 20 to 36 inches.	Rocklike caliche at depth of 20 to 36 inches.
Low water-holding capacity; low intake rate; best suited to sprinkler irrigation.	Shallow over hard caliche; leveling not practical.	Hard caliche at depth of 10 to 20 inches.	Hard caliche at depth of 10 to 20 inches.	Rocklike caliche at depth of 10 to 20 inches.
Deep sand; dune topography; unsuited to irrigation.	Deep sand; dune topography; unsuited to leveling.	Deep sand; dune topography; unsuited to terracing.	Deep sand; dune topography; unsuitable for waterways.	Deep sand; dune topography.

TABLE 4.--ENGINEERING

Map symbol	Soil	Suitability of soil for--				
		Road subgrade	Road fill	Topsoil	Location of highways: Materials	Location of highways: Drainage
ZfA	Zita fine sandy loam, 0 to 1 percent slopes.	Poor to fair--	Fair----------	Fair----------	Fair----------	Good-----
ZfB	Zita fine sandy loam, 1 to 3 percent slopes.					
ZmA	Zita loam, 0 to 1 percent slopes.	Poor----------	Poor to fair--	Good----------	Fair----------	Good-----

and clay particles in the plow layer. He has drastically changed the moisture regime in some areas by irrigating. The changes made by man will be reflected in the direction and rate of soil genesis in the future, but few results of these changes can as yet be seen, and some probably will not be evident for several centuries.

Parent material

The glaciers that moved southwest into the United States during the Pleistocene epoch did not reach Texas. They did, however, make the climate there cooler and more moist part of the time. There were some dry cycles, though. During these dry periods windblown materials, consisting of sand, silt, and clay in varying proportions, were deposited and shifted over the surface. During the wet periods, the materials were saturated with water that was high in minerals, including calcium. During the next dry cycle, caliche (calcium carbonate) was precipitated as a layer in the upper part of the windblown material.

It is thought that the parent material of soils such as the Amarillo was deposited by wind during the dry Illinoian stage of the Pleistocene epoch. These deposits of reddish sand mixed with various amounts of silt and clay occur extensively on the High Plains in this part of Texas (*6*).

The parent material of such soils as the Arch and Portales is believed to have been deposited as sediments in the basins and shallow valleys during the much later and more humid Early Wisconsin stage of the Pleistocene epoch. These deposits accumulated in lakes held in undrained depressions (*5*). Many of these basins were modified by subsequent deflation (wind erosion).

When the glaciers receded, the climate became more arid.

Relief

Cochran County is a part of an immense plain that slopes gently to the southeast. Differences in degree of slope are slight; consequently, there is very little variation in the soils because of relief. Most of the landscape consists of long, gentle swells that have a slope of less than 2 percent, but in areas next to playas and along drainageways, the slope is 3 to 8 percent. On the steeper slopes, soil is being eroded about as fast as it forms. Also, less moisture is taken in on the steeper slopes, and, as a result, the process of soil formation is slow.

The strong westerly winds have deposited soil materials on slopes facing east and removed soil material from those facing west. As a result, in many areas the soils are deeper on slopes facing east.

Time

The length of time that climate, living organisms, and relief have had to act on parent material affects the kind of soil that develops. Since the climate is dry in Cochran County, and the vegetation sparse, a long time is required to produce differences among the soils.

The soils of this county differ considerably in degree of development because they have been exposed to soil-forming processes for different lengths of time. Young soils, such as those of the Spur or Tivoli series, which have formed in materials of recent age, do not have well-expressed horizons. Mature soils, such as those of the Amarillo or Brownfield series, show marked horizon differences. Most of the mature soils are deep, are nearly level or gently sloping, and have been in place a long time.

Classification of Soils by Higher Categories

Classification consists of an orderly grouping of defined kinds of soils in a system designed to make it easier to remember soils, including their characteristics and interrelationships, and to organize and apply the results of experience and research to areas ranging in size from several acres to millions of square miles. The defined kinds of soils are placed in narrow classes for use in detailed soil surveys and for the application of knowledge within farms and fields. The many thousands of narrow classes are then grouped into progressively fewer and broader classes in successively higher categories so that information can be applied to large geographic areas.

Classes of soils defined on a comparable basis and of the same rank in a classification system comprise what

INTERPRETATIONS OF THE SOILS--Continued

Soil characteristics affecting--				
Irrigation	Land leveling	Field terraces and diversion terraces	Waterways	Remarks
High water-holding capacity; high intake rate; suited to surface or sprinkler irrigation.	Soil properties favorable; no limitations.	Soil properties favorable; no limitations.	Moderately erodible.	Strongly calcareous substrata.
High water-holding capacity; moderate intake rate; suited to surface or sprinkler irrigation.	Soil properties favorable; no limitations.	Soil properties favorable; no limitations.	Moderately erodible.	Strongly calcareous substrata.

is called a category. A comprehensive system of soil classification, one that will be useful in dealing with the soils of a small field as well as with the soils of a continent and areas of intermediate size, must therefore consist of a number of categories. The higher categories consist of fewer and broader classes than the lower categories.

The system of soil classification now used in the United States has six categories. Each successively higher category consists of a smaller total number of classes, and each of those classes has a broader range of characteristics. Thus, there are thousands of classes in the lowest category and three in the highest category. The intermediate categories are also intermediate in number of classes and in permissible span, or breadth, of each class. Beginning at the top, the six categories in the system of soil classification are the order, the suborder, the great soil group, the family, the series, and the type.

Four of the six categories have been widely used, and two have been used little. Of the two higher categories, the order and great soil group have been used widely. Similarly, the two lowest categories, the soil series and soil type, have been widely used. On the other hand, the categories of the suborder and family have never been fully developed and are therefore of little value now. In soil classification and mapping, attention largely has been given to the recognition of soil types and series within counties or comparable areas and to the subsequent grouping of the series into great soil groups and orders. The two lowest categories have been used primarily for study of soils of small geographic areas, whereas the categories of the order and great soil group have been used for the study of soils of large geographic areas.

Differences in the breadth, or span, of individual classes in each category are indicated by the total number of classes in that category. All soils in the United States are included in the three classes in the highest category, the soil order. These same soils are placed into some three dozen great soil groups, a category of somewhat lower rank. Going down the ladder to the next lower category in general use, approximately 7,000 soil series have been recognized in the United States. More series will be recognized as the study of soils continues, especially in areas where little work has been done in the past. The total number of soil types is not known exactly, because records are not maintained for individual soil types as they are for individual soil series. The total number of soil types recognized in the country as a whole, however, would be at least twice as large as the number of series. From comparisons of the respective numbers of orders, great soil groups, series, and types, it is immediately obvious that the ranges permitted in the properties of soils within one class in a category of high rank are broad, whereas ranges within individual classes in a caterogy of low rank are relatively narrow.

The nature of each of the four categories—order, great soil group, series, and type—will not be described at length in this section. The soil series and the soil type are defined in the Glossary. The soil order and the great soil group are described briefly in the subsequent paragraphs.

The highest category in the present system of soil classification consists of three classes, known as the zonal, intrazonal, and azonal orders. The *zonal order* comprises soils with evident, genetically related horizons that reflect the dominant influence of climate and living organisms in their formation. The *intrazonal order* comprises soils with evident, genetically related horizons that reflect the dominant influence of one or more local factors of parent material or topography over the effects of climate and living organisms. The *azonal order* comprises soils that lack distinct, genetically related horizons because of one or more of the following: youth of parent material, resistance of parent material to change, and steep topography.

Soils of all three orders can usually be found within a single county, as is true in Cochran County. Soils of two or all three orders may occur in a single field.

Primarily, the order indicates something about important factors of soil formation and something about degree of horizonation. But the ranges in properties are wide within any one order. Consequently, the total number of statements that are valid for all soils within an order is limited.

The great soil group is the next lower category that has been widely used in this country. This category indicates

a number of relationships in soil genesis and also something about fertility, suitability for crops or trees, and the like.

Each great soil group consists of a large number of soil series that have many internal features in common. All members of a single great soil group in either the zonal or intrazonal order have the same number and kind of definitive horizons in their profiles. These definitive horizons need not be expressed to the same degree, nor do they need to be of the same thickness in all soils within one great soil group. Specific horizons must be recognizable, however, in every profile of a soil series representing a given great soil group.

Great soil groups in the azonal order are defined in part on the basis of the nature of the profile and in part on the basis of history or origin of the soil. All members of an azonal great soil group have a number of internal features in common, but none of the three great soil groups in this order has distinct horizonation. Consequently, all of them still strongly resemble the material from which they are forming. Definitions of the great soil groups in the azonal order are based on the portion of the profile approximately comparable in thickness to the solum of associated great soil groups of the zonal and intrazonal orders.

The classification of soil series in Cochran County into great soil groups is shown in the following tabulation. Each series has been classified on the basis of the current understanding of the soils and their formation.

Order and great soil group	*Series*
Zonal—	
Chestnut	Bippus,[1] Lubbock, Stegall, Zita.[1]
Noncalcic Brown	Brownfield.
Reddish Chestnut	Amarillo, Arvana.
Intrazonal—	
Calcisol	Arch, Gomez, Mansker, Portales.
Grumusol	Randall.
Azonal—	
Alluvial	Spur.
Lithosol	Kimbrough, Potter.
Regosol	Berthoud, Drake, Tivoli.

[1] Intergrade to Calcisol.

Morphology and Classification of Soils in Cochran County

The relationship of the outstanding morphological characteristics of the soils of this county to the factors of soil formation is briefly discussed in this section. The soil series are also classified into great soil groups and orders, and a typical profile of each series is described.

Soil morphology is expressed in many ways in the soils of Cochran County. Some soils have distinct horizons; others have only faint horizons. The differentiation of horizons in soils is the result of several factors, among them (1) accumulation of organic matter, (2) leaching of carbonates and salts, (3) translocation of silicate clay minerals, and (4) reduction and transfer of iron. Two or more of these processes have operated in the development of horizons in most of the soils in this county. For example, the influence of the first three is reflected in the prominent horizons of Amarillo fine sandy loam; the influence of the first is dominant in the morphology of Tivoli fine sand.

Some organic matter has accumulated in the uppermost layer of all the soils in Cochran County to form an A1 horizon. Most of this organic matter is in the form of humus. The quantity ranges from one-fourth of 1 percent in some soils to 2 percent in others.

Leaching of carbonates and salts has occurred in most of the soils of the county, although it has been limited in some. Leaching has permitted the subsequent translocation of silicate clay minerals in the more mature soils.

Translocation of silicate clay minerals has contributed to the development of horizons in the Amarillo, Arvana, Brownfield, Lubbock, and Stegall soils.

Reduction and transfer of iron has occurred only in the poorly drained soils of the playa beds.

A prominent horizon of calcium carbonate accumulation, locally called "caliche," is a significant characteristic of most of the soils in Cochran County. This layer is usually called a Cca horizon, as in the Potter soils; a Drca horizon, as in the Arvana soils; or a Dr horizon, as in the Kimbrough soils.

The caliche layers in the soils of this county have formed in one of two ways or a combination of the two.

The first is the leaching of carbonates from the upper horizons. The depth to which these carbonates move in the soil is related to the amount of moisture that enters the soil. In more humid regions the carbonates may be leached out of the soil. Since rainfall is low in Cochran County, the amount of water that percolates through the profile is not sufficient to remove the calcium carbonate that was in the parent material. The usual result is the accumulation of calcium carbonate at about the depth to which surface water ordinarily percolates. The Amarillo soils have a Cca horizon that was formed in this manner.

The second manner in which the carbonate layers have formed is by precipitation of calcium from a high water table at some time in the past. The water table could have been very near, or even above, the surface, and it probably fluctuated up and down in alternate wet and dry periods. The Arch and Portales soils have carbonate layers that formed in this manner. Of course, as the soils have developed, there has been some downward movement of carbonates.

The carbonate horizons that have formed by downward percolation of water usually have a pinkish color. This color may be due to the mixing of whitish carbonates with reddish soil material. The carbonate layers that have been formed by precipitation from, or that have been influenced by, a high water table usually have a whitish color. Figure 19 shows a thick, white calcium carbonate horizon of the kind that can result from precipitation of carbonate from a high water table. Some downward movement of carbonates has occurred also.

Some soils do not have calcium carbonate horizons, either because of their age or because of the nature of the parent materials. The Tivoli and Brownfield soils lack carbonate horizons because their parent material contained insufficient amounts of carbonates. Some Brownfield soils are underlain by buried soils that do have a calcium car-

Figure 19.—**Soil profile showing thick Cca horizon like that in the Arch, Portales, and Zita soils.**

bonate horizon. The Drake soils are very high in carbonates, but they are so young that downward movement of these materials has not occurred.

Zonal order

Nearly 83 percent of the area of Cochran County consists of soils of the zonal order. Three great soil groups are represented: Chestnut, Noncalcic Brown, and Reddish Chestnut.

CHESTNUT SOILS

The soils in this group, as they occur in this county, are in a slightly lower position than surrounding soils. Because of their position they have received some extra moisture. They may also have received, very gradually, an accumulation of soil material from surrounding soils.

These soils have a thick, dark-brown to dark grayish-brown A horizon. This horizon is dominantly saturated with bivalent cations, has a narrow carbon-nitrogen ratio, and is about 1 or 2 percent organic matter.

There are four series in this group, the Bippus, Lubbock, Stegall, and Zita. The Lubbock and Stegall soils have a thick, strong B horizon well enriched with clay. The Bippus and Zita soils usually do not have a B horizon; however, they have a very thick A horizon, and in the lower part of the A there may be a slight "clay bulge," or increase in clay content. The Bippus and Zita soils are intergrades to Calcisols. The Bippus, Lubbock, and Zita soils have a strong calcium carbonate horizon at a depth of 1½ to 4 feet. The Stegall soils have a Drca horizon of indurated caliche at a depth of 1 to 3 feet.

Climate and living organisms have had the greatest influence in determining the morphological characteristics of the Chestnut soils in this county. However, their low position in the landscape, which has allowed them to receive extra water, has also had an influence on their development.

NONCALCIC BROWN SOILS

Brownfield soils are the only soils of the Noncalcic Brown great soil group in Cochran County. These soils are undulating. Their parent material is wind-deposited sand and is underlain in many places by a more clayey buried soil.

The Noncalcic Brown soils in this area have a thick A horizon of light-brown fine sand over a thick B horizon of sandy clay loam. The organic-matter content of the A horizon generally is less than one-half of 1 percent. There is no calcium carbonate horizon.

REDDISH CHESTNUT SOILS

This is the most extensive group of soils in Cochran County. It comprises more than 60 percent of the acreage. The Amarillo and Arvana series are in this group. These soils occur on broad, nearly level to gently sloping areas in most parts of the county. They have a thick, brown to reddish-brown A horizon that grades to a prominent B horizon of illuvial silicate clays. The Amarillo soils have a thick calcium carbonate horizon, and the Arvana soils have a horizon of indurated caliche (Drca).

The thick A horizon has a high base-exchange capacity and a narrow carbon-nitrogen ratio. The organic-matter content is 0.6 to 1.3 percent.

Although the color of these soils has been influenced by parent materials, their genetically related horizons and other characteristics show that the predominant influences in their formation have been those of climate and living organisms.

Intrazonal order

About 11 percent of the area of Cochran County consists of soils of the intrazonal order. Two great soil groups are represented: Calcisols and Grumusols.

CALCISOLS

The outstanding characteristic of these soils is a thick horizon of calcium carbonate 10 to 36 inches below the surface. Free lime occurs throughout the profile.

The horizon sequence of these soils is A, AC, Cca, and C. The color of the A horizon ranges from grayish brown to pale brown or even light gray. The A horizon is moderately thick to thick and in the virgin condition grades to the AC horizon. The AC horizon is lighter colored than the A, and is higher in free lime content.

These soils are saturated with bases and have a narrow carbon-nitrogen ratio. The organic-matter content is 0.5 to 2 percent.

Four series in this county are in the Calcisol group: the Arch, Gomez, Mansker, and Portales. The Arch, Gomez, and Portales soils occur in a slightly lower position than surrounding soils. Their parent material appears to be late Pleistocene limy sediments that seem to have been calcified as a result of a shallow water table prior to the development of the present soil. The parent

material of the Gomez soils is much more sandy than that of the Arch or Portales soils. The Portales soils are deeper than the Arch. This may be because the Portales soils are a little more mature, or because they have a more favorable microrelief and consequently have received extra water that speeded the leaching of lime.

The morphology of the Arch, Gomez, and Portales soils has been most strongly influenced by parent material and time.

Mansker soils have slopes of up to 5 percent and consequently have been strongly influenced by relief.

Theoretically Arch soils should in time develop into soils resembling those of the Portales series, and then into Chestnut soils resembling those of the Zita series.

Apparently the Calcisols of Cochran County do not have an illuvial B horizon, because there is free lime throughout the profile. Leaching of carbonates and salts from the upper part of the profile seems to be a prerequisite to the translocation of the silicate clays.

GRUMUSOLS

The only Grumusols in Cochran County are the Randall soils. These soils have developed in playa beds from clayey material. Because of their low position in the landscape, they developed under wet conditions.

These are the only soils in Cochran County that are high in montmorillinite clay. They may be either calcareous or noncalcareous, but usually they have a pH of more than 7.0.

Unless leveled by farming, these soils have a gilgai microrelief. They also have slickensides within the profile, but these are not prominent in the Grumusols of this county.

These soils receive much outside water as runoff from surrounding soils. They may be inundated for only a few days or for several months. There is, however, a substantial excess of evapotranspiration over precipitation. This results in drying of the soil to such a degree that large cracks develop. Surface material sloughs into these cracks, or soil material is washed or blown into them. When the soil is wet again, swelling and shearing take place. This mass movement makes the soils unstable.

The reduction and transfer of iron and manganese has occurred in these soils. This is indicated by the gray colors of the lower part of the horizon. Fine, hard ferromanganese concretions are common in some profiles.

Azonal order

About 6 percent of the area of Cochran County consists of soils of the azonal order. Three great soil groups are represented: Alluvial soils, Lithosols, and Regosols. The azonal soils usually have only a weak A1 horizon.

ALLUVIAL SOILS

The Spur soils are the only Alluvial soils in Cochran County. They occur only in draws or drainageways.

Spur soils are immature. They are brown or grayish brown in color and have free lime throughout the profile. They have no calcium carbonate horizon and are commonly stratified below a depth of 2 feet. Time is the dominant factor in their formation. They do not have distinct horizons because they have not been exposed to the processes of soil formation long enough.

Figure 20.—**Profile of a Kimbrough soil showing thin profile over indurated calcium carbonate.**

LITHOSOLS

The Kimbrough and Potter soils are in this group. Both are less than 10 inches deep.

The Kimbrough soils are very shallow because of their parent material, which was derived from thick beds of indurated calcium carbonate (fig. 20).

The Potter soils are very shallow because of relief. The slopes are so steep that geologic erosion removes the soil almost as fast as it develops.

REGOSOLS

This group includes the Berthoud, Drake, and Tivoli series. These soils have weak horizonation, either because of the nature of the parent material or because of age.

The Berthoud soils developed from recent colluvium along the slopes of the draws. They have a weak A horizon slightly darkened by organic matter and a faint but evident calcium carbonate horizon. Free lime occurs throughout the profile.

The Drake soils developed from eolian material very high in lime. This material was deposited as dunes to the leeward of playas during the late Wisconsin stage. It is probably part of the Tahoka formation. These soils are very immature because of the nature of the parent material and because of age. Only a weak A horizon is evident.

The Tivoli soils developed from material that was about 95 percent quartz sand. This material contained little clay or minerals subject to weathering; hence, subsurface horizonation is lacking. A weak A1 darkened by organic matter is usually the only identifiable horizon. Parent material is the dominant factor in the development of these soils.

Representative profiles

Representative profiles of each of the soil series in Cochran County are described in detail in the following pages.

AMARILLO SERIES

This series consists of deep, brown to reddish-brown, well-drained soils of the uplands. They have developed from unconsolidated, moderately sandy sediments that were reworked by wind during the Pleistocene epoch. The Amarillo soils have formed under a grass cover on broad, nearly level to gently sloping areas. They are extensive and occur in all parts of the county.

The Amarillo soils differ from the Arvana in having no indurated caliche within 36 inches of the surface. They are less sandy than the Brownfield soils and darker colored. They are redder, they have less calcium, and they are usually deeper than the Mansker, Portales, and Zita soils. They have a less clayey and more friable subsoil than the Lubbock soils.

Because the Amarillo series is extensive and is important in the classification scheme, a profile of each type is described. The organic-matter content of the loamy fine sands is usually less than 1 percent; that of the loams is usually more than 1 percent; and that of the fine sandy loams ranges from about 0.7 percent to 1.3 percent.

Amarillo fine sandy loam.—The following profile of Amarillo fine sandy loam is located 1.4 miles south and 0.2 mile west of the courthouse in Morton. Figure 21 shows the horizon sequence.

A1p—0 to 10 inches, reddish-brown (5YR 4/4) fine sandy loam; dark reddish brown (5YR 3/4) when moist; structureless; slightly hard when dry, friable when moist; neutral; abrupt boundary.

B2—10 to 27 inches, reddish-brown (5YR 4/3) sandy clay loam; dark reddish brown (5YR 3/3) when moist; compound structure—moderate coarse prismatic and weak granular; hard when dry, friable when moist; many fine and very fine pores, many worm casts; neutral; gradual boundary.

B3—27 to 44 inches, yellowish-red (5YR 5/6) sandy clay loam; yellowish red (5YR 4/6) when moist; less clayey than B2; compound structure—weak coarse prismatic and granular; consistence same as for B2; weakly calcareous; clear boundary.

Cca—44 to 62 inches, pink (7.5YR 8/4) sandy clay loam; pink (7.5YR 7/4) when moist; estimated 50 percent by volume of $CaCO_3$ equivalent, 30 percent of which is hard concretions less than 30 millimeters in diameter; very strongly calcareous; diffuse boundary.

C—62 to 78 inches +, reddish-yellow (5YR 6/6) sandy clay loam; yellowish red (5YR 5/6) when moist; about 15 to 20 percent by volume of $CaCO_3$ equivalent; very strongly calcareous.

Thickness of the A horizon ranges from 6 to 12 inches. Color ranges from reddish brown to brown (values 4 to 5 dry, chromas 3 to 4, hues 5YR to 7.5YR). In the virgin condition the structure of the A horizon is weak granular.

Thickness of the B2 horizon ranges from 10 to 20 inches. Color is usually reddish brown (hue 5YR). Texture ranges from light to heavy sandy clay loam. Structure ranges from moderate coarse prismatic to weak or moderate fine or medium subangular blocky or granular. Reaction of the A and B2 horizons ranges from neutral to mildly alkaline.

Thickness of the B3 horizon ranges from 10 to 50 inches. Color is usually yellowish red but ranges to red (hues 2.5YR to 5YR). Structure is weak and varies from prismatic to subangular blocky or granular. Reaction ranges from mildly alkaline to moderately alkaline. Effervescence with acid ranges from none to strong.

Depth to the Cca horizon is generally between 36 and 54 inches but ranges from 2 to 7 feet. Thickness of this horizon is usually about 18 inches but ranges from 6 to 36 inches. Color ranges from pinkish white to yellowish red, (hues 5YR to 7.5YR). Hard and soft $CaCO_3$ concretions make up 30 to 60 percent of this horizon. In a few places the upper part of the Cca horizon is slightly to moderately cemented.

The C horizon ranges from reddish yellow to yellowish red.

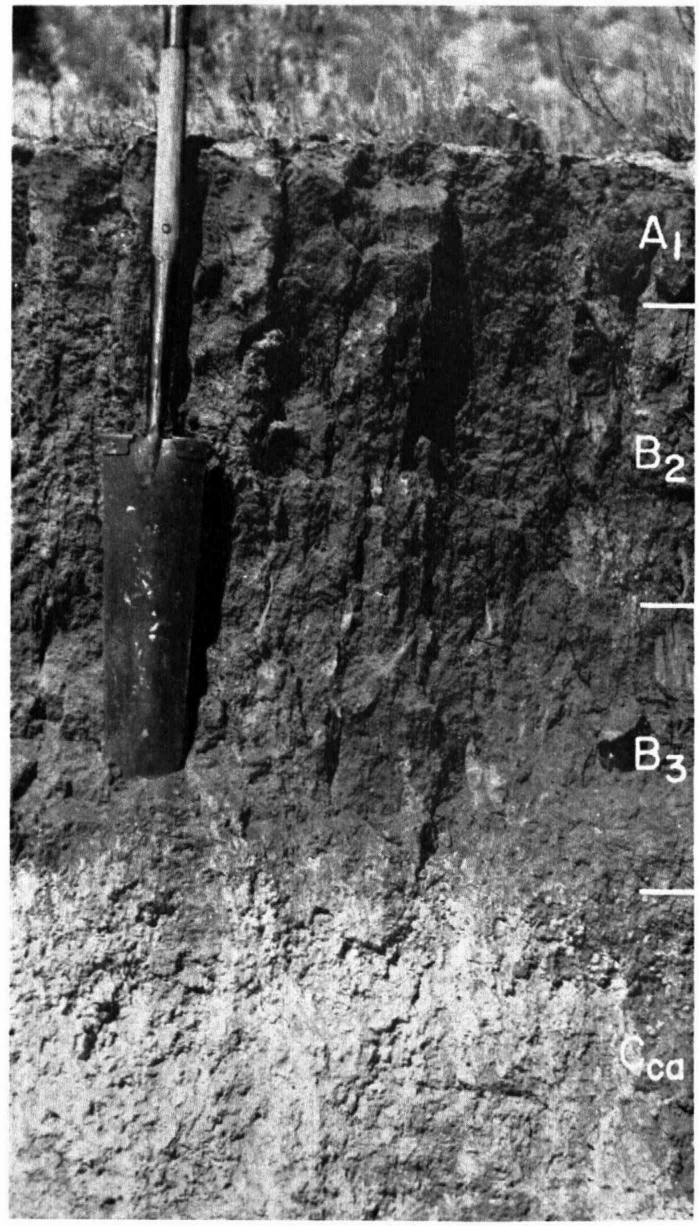

Figure 21.—**Profile of Amarillo fine sandy loam.**

Amarillo loam.—The following profile of Amarillo loam is located 6 miles east and 2 miles south of Morton, 1,500 feet west and 1,000 feet north of the southeast corner of Labor 8, League 86.

Ap—0 to 8 inches, reddish-brown (5YR 4/4) loam; dark reddish brown (5YR 3/4) when moist; structureless; hard when dry, friable when moist; neutral; abrupt boundary.

B21—8 to 18 inches, reddish-brown (5YR 4/3) sandy clay loam; dark reddish brown (5YR 3/3) when moist; moderate, coarse, prismatic and weak, subangular blocky structure; very hard when dry, friable when moist; many fine and very fine pores, common medium pores, common worm casts; neutral; gradual boundary.

B22—18 to 24 inches, reddish-brown (5YR 5/4) sandy clay loam; reddish brown (5YR 4/4) when moist; weak, coarse, prismatic and subangular blocky structure; hard when dry, friable when moist; many fine and very fine pores; neutral; gradual boundary.

B3—24 to 38 inches, yellowish-red (5YR 5/6) sandy clay loam; yellowish red (5YR 4/6) when moist; weak, coarse, prismatic structure; weakly calcareous; abrupt boundary.

Cca—38 to 58 inches, pink (5YR 8/4) sandy clay loam; pink (5YR 7/4) when moist; about 50 percent by volume of $CaCO_3$ equivalent, 30 percent of which is hard concretions less than 5 centimeters in diameter; very strongly calcareous; diffuse boundary.

C—58 to 80 inches +, reddish-yellow (5YR 6/6) sandy clay loam; yellowish red (5YR 5/6) when moist; about 15 percent by volume of $CaCO_3$ equivalent; very strongly calcareous.

Thickness of the A horizon ranges from 6 to 10 inches. Color varies from reddish brown to brown (values 4 to 5 dry, chromas 3 and 4, hues 5YR and 7.5YR). Texture generally is loam but ranges to light sandy clay loam.

Thickness of the B21 horizon ranges from 6 to 15 inches. Color is usually reddish brown (hue 5YR). Structure ranges from moderate coarse prismatic to subangular blocky and is in many places a composite of the two.

The range in characteristics in the B22 horizon is about the same as in the B21, but in a given profile the B22 ordinarily is lighter colored and a little less clayey than the B21 and has weaker structure.

Thickness of the B3 horizon ranges from 10 to 20 inches. Color ranges from reddish brown to reddish yellow. Structure is weak and ranges from prismatic to subangular blocky or granular. Effervescence with acid ranges from slight to strong.

Depth to the Cca horizon ranges from 28 to 60 inches but averages 36 to 42 inches. Thickness of this horizon is usually about 18 inches but ranges from 10 to 30 inches. Color ranges from pinkish white to yellowish red. In places the upper part of the Cca is slightly to moderately cemented.

The C horizon is sandy clay loam. It is several feet thick and ranges from reddish yellow to yellowish red.

Amarillo loamy fine sand.—The following profile of Amarillo loamy fine sand is located 7 miles southwest of Lehman, 800 feet east and 800 feet north of the southwest corner of Labor 5, League 134.

A1—0 to 12 inches, brown (7.5YR 4/4) loamy fine sand; dark brown (7.5YR 3/4) when moist; weak, granular structure; soft when dry, very friable when moist; many fine pores, few worm casts; neutral; clear boundary.

B2—12 to 30 inches, reddish-brown (5YR 3/4) sandy clay loam; dark reddish brown (5YR 3/4) when moist; moderate, coarse, prismatic structure; hard when dry, friable when moist; many fine and medium pores; common worm casts; neutral; gradual boundary.

B3—30 to 56 inches, red (2.5YR 4/6) sandy clay loam; dark red (2.5YR 3/6) when moist; weak, coarse, prismatic structure; hard when dry, friable when moist; mildly alkaline, becoming weakly calcareous in lower 6 inches; abrupt boundary.

Cca—56 to 72 inches, pink (5YR 7/4) sandy clay loam; light reddish brown (5YR 6/4) when moist; hard when dry, friable when moist; an estimated 40 to 50 percent, by volume, of $CaCO_3$ equivalent; very strongly calcareous; diffuse boundary.

C—72 to 80 inches +, reddish-yellow (5YR 6/6) sandy clay loam; yellowish red (5YR 5/6) when moist; about 15 to 20 percent, by volume, of $CaCO_3$ equivalent; very strongly calcareous.

Thickness of the A horizon ranges from 8 to 14 inches. Color varies from reddish brown to brown (values of 4 to 5.5 dry, chromas 3 to 5, hues 5YR and 7.5YR).

Thickness of the B2 horizon ranges from 10 to 20 inches. Color is usually reddish brown (hues 2.5YR and 5YR). Texture ranges from light to heavy sandy clay loam. Structure ranges from moderate coarse prismatic to weak or moderate fine or medium subangular blocky or granular. Reaction ranges from neutral to mildly alkaline.

Thickness of the B3 horizon ranges from 20 to 50 inches. Color ranges from red to yellowish red (hues 2.5YR and 5YR). Texture ranges from light to medium sandy clay loam. Structure ranges from weak coarse prismatic to subangular blocky or granular. Effervescence with acid ranges from none to strong.

Depth to the Cca horizon ranges from 38 to 80 inches. Thickness of this horizon is usually about 15 inches but ranges from 6 to 30 inches. Color ranges from pink to yellowish red (hue 5YR). Hard and soft concretions of $CaCO_3$ make up 30 to 60 percent of this horizon.

The C horizon is sandy clay loam. It is several feet thick and ranges from reddish yellow to yellowish red.

ARCH SERIES

This series consists of shallow, light-gray to grayish-brown, well-drained, high-lime soils. They have developed from chalky, unconsolidated, old alluvium or plains outwash that appears to have been modified by calcium carbonate deposited from ground water. The Arch soils have formed under a cover of short and mid grass. They are nearly level and are slightly lower than surrounding upland soils. They are inextensive, and most of the acreage is in the northern part of the county.

The Arch soils are lighter colored than the Portales soils and less deep. They are lighter colored than the Mansker soils and more nearly level than the Drake soils.

The following profile of Arch loam is located 0.1 mile north and 0.2 mile west of the southeast corner of Labor 18, League 160.

A1—0 to 6 inches, light brownish-gray (10YR 6/2) loam; dark grayish brown (10YR 4/2) when moist; weak, granular structure; hard when dry, friable when moist; common, fine $CaCO_3$ concretions on surface; very strongly calcareous; clear boundary.

AC—6 to 15 inches, light-gray (10YR 7/2) light clay loam; grayish brown (10YR 5/2) when moist; weak, granular structure; consistence same as above; many fine and very fine pores, few medium pores, common worm casts, few very fine $CaCO_3$ concretions; very strongly calcareous; clear boundary.

Cca—15 to 42 inches, white (10YR 8/2) clay loam; light gray (10YR 7/2) when moist; slightly hard when dry, friable when moist; very strongly calcareous; diffuse boundary.

C—42 to 68 inches +, light-gray (10YR 7/2) clay loam; light brownish gray (10YR 6/2) when moist; consistence same as for Cca; very strongly calcareous.

Thickness of the A horizon ranges from 4 to 8 inches. In the fine sandy loams, texture ranges from light to heavy fine sandy loam. In the loams, texture ranges to a light clay loam. Color of the A horizon ranges from light gray to grayish brown (hue 10YR).

Thickness of the AC horizon ranges from 6 to 12 inches. In the fine sandy loams, texture varies from loam to sandy clay loam. In the loams, it ranges from loam to clay

loam. Color is the same as for the A horizon, but in a given profile the AC horizon is usually a little lighter colored than the A.

Depth to the Cca horizon ranges from 10 to 22 inches. Thickness of this horizon ranges from 12 to 42 inches. Color ranges from white to light gray. The calcium carbonate equivalent ranges from 40 to 60 percent, by volume.

The C horizon ranges from light gray to very pale brown. The $CaCO_3$ content is about half that of the Cca horizon.

This soil is very strongly calcareous. Hard, medium to fine concretions of $CaCO_3$ may occur throughout the profile.

ARVANA SERIES

This series consists of shallow to moderately deep, brown to reddish-brown, well-drained soils of the uplands. They have developed from a thin mantle of moderately sandy, unconsolidated, calcareous, eolian sediments over hard, platy, stonelike caliche. The Arvana soils have formed under a cover of short and mid grasses. They are nearly level to gently sloping. They are inextensive and occur in the northern part of the county.

The Arvana soils differ from the Amarillo soils in having indurated caliche within 36 inches of the surface. They are deeper than the Kimbrough soils and redder and less clayey than the Stegall soils.

The following profile of Arvana fine sandy loam is located 370 feet south and 200 feet west of the northeast corner of Labor 9, League 121.

A1p—0 to 8 inches, brown (7.5YR 4/4) fine sandy loam; dark brown (7.5YR 3/4) when moist; structureless; slightly hard when dry, very friable when moist; mildly alkaline; abrupt boundary.

B2—8 to 20 inches, reddish-brown (5YR 4/4) sandy clay loam; dark reddish brown (5YR 3/4) when moist: compound structure—moderate coarse prismatic and weak subangular blocky; very hard when dry, friable when moist; many fine and very fine pores; few worm casts; mildly alkaline; gradual boundary.

B3—20 to 30 inches, yellowish-red (5YR 5/6) sandy clay loam: yellowish red (5YR 4/6) when moist; less clayey than B2; weak, coarse, prismatic structure; hard when dry, friable when moist; many fine and very fine pores; weakly calcareous; abrupt boundary.

Drca—30 to 45 inches +, indurated platy caliche.

Thickness of the A horizon ranges from 6 to 10 inches. Texture varies from fine sandy loam to light loam. Color ranges from reddish brown to brown (values of 4 to 5 dry, chromas 3 and 4, hues 5YR and 7.5YR). In the virgin condition the structure of the A horizon is weak granular. The reaction ranges from neutral to mildly alkaline.

Thickness of the B2 horizon ranges from 6 to 16 inches. Color is usually reddish brown (hue 5YR). Texture ranges from light to medium sandy clay loam. Structure varies from moderate coarse prismatic to compound prismatic and weak subangular blocky or granular. Reaction ranges from neutral to mildly alkaline.

Thickness of the B3 horizon ranges from 4 to 12 inches. This horizon is usually absent in the shallow phase. Color varies from red to yellowish red (hues 2.5YR and 5YR). Structure is weak and varies from prismatic to granular. Reaction ranges from mildly alkaline to moderately alkaline. Effervescence with acid is generally slight but is strong in some places, at least in the lower 4 to 6 inches of this layer.

Depth to the Drca horizon ranges from 10 to 36 inches. Areas in which the depth is less than 20 inches are mapped as a shallow phase. The Drca horizon is usually 1 to 2 feet thick over softer caliche that is many feet thick. The hardened caliche consists of indurated plates or slabs from 1 to 3 feet in diameter and 1 to 3 inches thick. These plates are smooth on top, knobby beneath, and laminated within. They overlap from 20 to 50 percent.

BERTHOUD SERIES

This series consists of shallow to moderately deep, brown to grayish-brown, well-drained sloping soils. They have developed from moderately sandy, calcareous, local colluvial materials. The Berthoud soils have formed under a cover of mid grass on short slopes. They are very minor in extent, and most of them occur along Sulphur Draw in the southeastern part of the county.

The Berthoud soils differ from the Bippus soils in being lighter in color, in having a thinner A horizon, and in occurring on steeper slopes. They are usually deeper than the Mansker soils and they lack a prominent calcium carbonate horizon. They are much deeper than the closely associated Potter soils.

The following profile of Berthoud fine sandy loam is located 2.7 miles south of the intersection of Farm Roads 301 and 1780, on the west side of the road and on the north side of Sulphur Draw, or 0.1 mile north of the southeast corner of Labor 20, League 53.

A1—0 to 9 inches, brown (7.5YR 5/2) fine sandy loam; dark brown (7.5YR 4/2) when moist; weak, granular structure; slightly hard when dry, very friable when moist; few fine $CaCO_3$ concretions; strongly calcareous; gradual boundary.

AC—9 to 18 inches, brown (7.5YR 5/4) sandy clay loam; brown (7.5YR 4/4) when moist; compound structure—weak coarse prismatic and granular; hard when dry, friable when moist; many fine and very fine pores, common worm casts; concretions same as in A1 horizon; strongly calcareous; clear boundary.

Cca—18 to 65 inches +, light-brown (7.5YR 6/4) sandy clay loam; brown (7.5YR 5/4) when moist; common fine and very fine $CaCO_3$ concretions; films and threads of segregated $CaCO_3$; very strongly calcareous.

Thickness of the A1 horizon ranges from 6 to 15 inches. Texture varies from fine sandy loam to light sandy clay loam. The upper part of the horizon commonly is more sandy, especially in the thicker profiles. Color ranges from brown to grayish brown (hues 7.5YR and 10YR). Structure varies from weak granular to weak prismatic.

Thickness of the AC horizon ranges from 6 to 15 inches. Textures varies from light to medium sandy clay loam and, in places, loam. Color ranges from brown to pale brown. Structure is the same as for the A horizon.

The Cca horizon is faint but evident. Depth to the Cca ranges from 15 to 30 inches. Thickness varies greatly because, in many areas, this soil overlies a buried soil at a depth of more than 3 feet. Texture is the same as for the AC horizon. Color varies from light brown to very pale brown.

Hard, medium to fine concretions of $CaCO_3$ usually occur throughout this soil. The buried soil generally is similar to the parent material of the Amarillo soils.

BIPPUS SERIES

This series consists of moderately deep to deep, dark-brown to dark grayish-brown, well-drained soils. They have developed from strongly calcareous, moderately fine

textured alluvium transported from nearby uplands. The Bippus soils have formed under a cover of mid and short grasses in concave areas along the bottoms of the draws. The slope range is from one-half of 1 percent to 1½ percent. These soils are very minor in extent and occur mostly along Sulphur Draw.

The Bippus soils differ from the Spur soils in being much darker colored and noncalcareous in the upper horizons. They lack the strong calcium carbonate horizon of the Zita soils, and they are much darker colored than the Berthoud soils.

The following profile of Bippus loam is located 12 miles south of Whiteface in Sulphur Draw on the west side of the highway.

A11—0 to 8 inches, dark grayish-brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) when moist; weak, granular structure; hard when dry, friable when moist; mildly alkaline; clear boundary.

A12—8 to 30 inches, very dark grayish-brown (10YR 3/2) clay loam; very dark brown (10YR 2/2) when moist; compound structure—moderate medium to coarse subangular blocky and weak granular; very hard when dry, friable when moist; many fine and very fine pores, common worm casts; mildly alkaline; clear boundary.

ACca—30 to 48 inches, brown (7.5YR 4/4) clay loam; dark brown (7.5YR 3/4) when moist; weak subangular blocky and granular structure; hard when dry, friable when moist; many fine and very fine pores; films and threads of $CaCO_3$ on ped surfaces, few fine concretions; very strongly calcareous; clear boundary.

Cca—48 to 66 inches +, brown (7.5YR 5/4) clay loam; brown (7.5YR 4/4) when moist; slightly hard when dry, friable when moist; common, hard and soft, fine and very fine concretions of $CaCO_3$; very strongly calcareous.

Thickness of the A11 horizon ranges from 4 to 15 inches. Color ranges from dark brown to very dark grayish brown, the lighter colors being in the fine sandy loams. Texture varies from fine sandy loam to light clay loam. Structure ranges from weak granular to subangular blocky. Reaction ranges from neutral to mildly alkaline. Small areas may be calcareous because of a few inches of recent overwash.

Thickness of the A12 horizon ranges from 6 to 30 inches. Color is the same as for the A11 horizon. Texture ranges from sandy clay loam in the fine sandy loams to clay loam in the loams. Structure ranges from weak to moderate and from subangular blocky to granular.

Thickness of the ACca horizon ranges from 6 to 30 inches. Color varies from brown to grayish brown or light brownish gray. Segregation of $CaCO_3$ is usually less than 5 percent. Texture is the same as for the A12 horizon.

Color of the Cca horizon ranges from brown to very pale brown or light brownish gray. Segregation of $CaCO_3$ is usually less than 15 percent. Texture varies from loam to clay loam and, in the fine sandy loams, to sandy clay loam.

BROWNFIELD SERIES

This series consists of deep, light-brown to brown, well-drained sandy soils of the uplands. They have developed from unconsolidated, very sandy, eolian material. The Brownfield soils have formed under a cover of tall grass on broad, undulating areas. They are extensive and occur mostly in the southern and western parts of the county.

The Brownfield series differ from the Amarillo in having a more sandy, lighter colored A horizon and in lacking a calcium carbonate horizon. They differ from the Tivoli soils in having a more clayey subsoil and in lacking a duned topography.

About 30 percent of the acreage of Brownfield soils is underlain by a buried soil at a depth of 24 to 60 inches. Described below is a modal profile of Brownfield fine sand, thick surface. This profile is located 9 miles south of Bledsoe, 0.2 mile northwest of the windmill in Section 12, Block W.

A11—0 to 6 inches, brown (7.5YR 5/3) fine sand; brown (7.5YR 4/3) when moist; single grain; loose when dry or moist; neutral; clear boundary.

A12—6 to 24 inches, light-brown (7.5YR 6/4) fine sand; brown (7.5YR 5/4) when moist; single grain; loose when dry or moist; neutral; clear boundary.

B2—24 to 48 inches, red (2.5YR 4/) sandy clay loam; dark red (2.5Y 3/6) when moist; compound structure—moderate coarse prismatic and medium subangular blocky; very hard when dry; friable when moist; few fine pores; neutral; gradual boundary.

B3—48 to 60 inches, reddish-yellow (5YR 6/6) sandy clay loam; yellowish red (5YR 5/6) when moist; more sandy than B2; weak, subangular blocky structure; hard when dry, friable when moist; neutral; diffuse boundary.

C—60 to 80 inches, reddish-yellow (5YR 6/8) light sandy clay loam; yellowish red (5YR 5/8) when moist; mildly alkaline, with very small pockets that are weakly calcareous.

About 30 percent of the acreage of the Brownfield soils is underlain by a buried soil (fig. 22) at a depth of 24 to 60 inches. Described below is a profile of Brownfield fine sand over a buried soil.

A11—0 to 10 inches, pale-brown (10YR 6/3) fine sand; brown (10YR 5/3) when moist; single grain; loose when dry or moist; neutral; clear boundary.

A12—10 to 18 inches, light-brown (7.5YR 6/4) fine sand; brown (7.5YR 5/4) when moist; structure and consistence same as in A11; neutral; clear boundary.

B2—18 to 26 inches, reddish-brown (5YR 5/4) sandy clay loam; reddish brown (5YR 4/4) when moist; compound structure—weak coarse prismatic and moderate medium subangular blocky; hard when dry, friable when moist; common fine pores; neutral; clear boundary.

B2b—26 to 44 inches, yellowish-red (5YR 5/6) sandy clay; yellowish red (5YR 4/6) when moist; vertical faces of peds are grayish brown (10YR 5/2) when dry; yellow to gray, common, medium, distinct mottles within peds; compound structure—strong medium prismatic and coarse blocky; extremely hard when dry, firm when moist; sticky and plastic when wet; roots follow faces of peds; few fine, hard, concretions of iron or manganese; mildly alkaline; clear boundary.

Ccab—44 to 68 inches, white (10YR 8/2) clay loam; light gray (10YR 7/2) when moist; estimated 50 percent by volume of $CaCO_3$ equivalent, 20 percent of which is hard fine concretions; very strongly calcareous.

Thickness of the A11 horizon generally ranges from 4 to 8 inches. Thickness of 10 inches, as in the second profile described, is unusual. Color varies from brown to light brown or pale brown (hues 7.5YR and 10YR, values 5 and 6 dry, and chromas 3 to 4).

Thickness of the A12 horizon ranges from 5 to 30 inches. Color generally is light brown or pale brown and is lighter by at least one-half of one value unit than that of the A11, unless the horizons have been mixed by plowing. Texture of both the A11 and A12 is fine sand. The darker color of the A11 horizon is the result of accumulation of organic

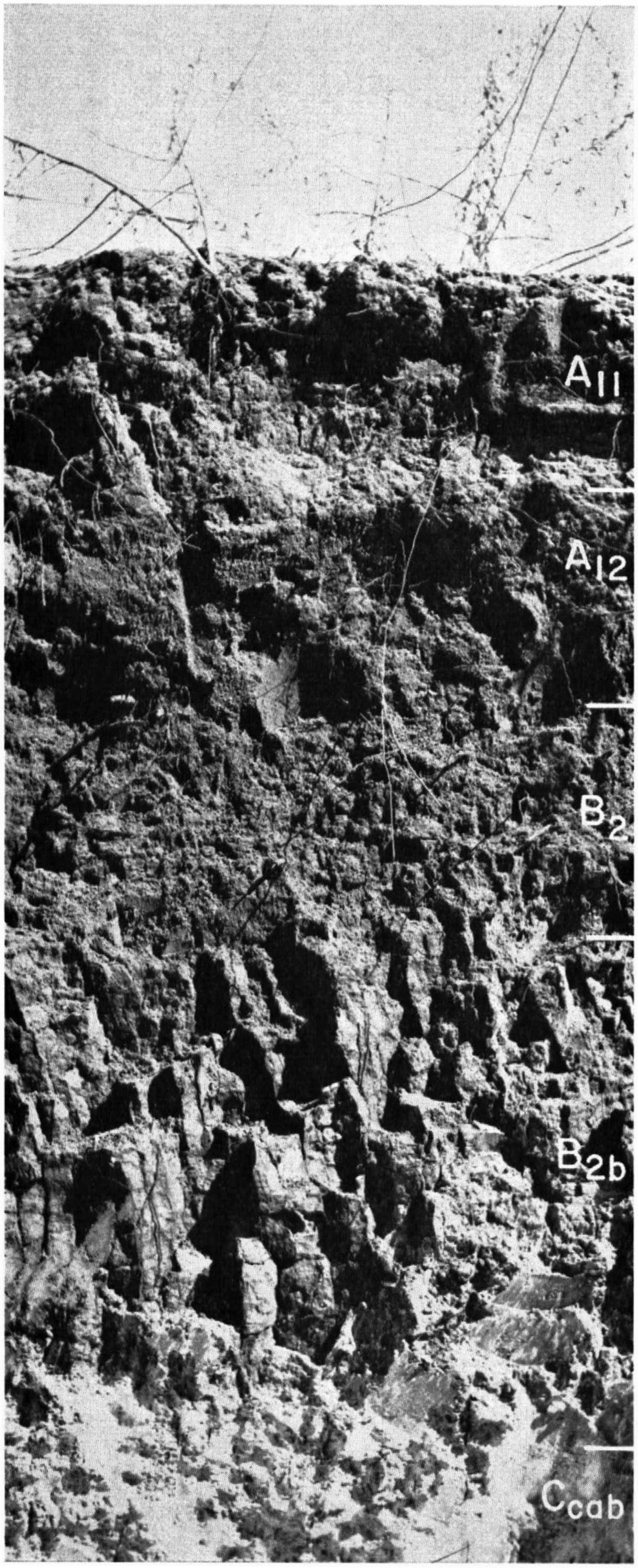

Figure 22.—**Brownfield fine sand over a buried soil.**

matter. Reaction of both the A11 and A12 horizons ranges from pH 6.5 to pH 7.2. Areas where the combined thickness of the A11 and A12 horizons is less than 18 inches are mapped as a thin-surface phase.

Thickness of the B2 horizon ranges from 12 to 30 inches if there is no buried profile within 40 inches of the surface. Color ranges from red to reddish brown (values 4 to 5 dry, chromas 4 to 6, hues 2.5 YR to 5YR). Texture ranges from light sandy clay loam to light sandy clay. Structure ranges from weak to moderate and from prismatic to subangular blocky.

Thickness of the B3 horizon varies from 10 to 30 inches. If there is a buried soil within 40 inches of the surface, the B3 may be lacking. Color ranges from red to reddish yellow. Texture varies from fine sandy loam to sandy clay loam. Structure is weak and ranges from prismatic to subangular blocky.

The C horizon is very similar in color and texture to the B3 horizon. In reaction, it ranges from neutral to moderately alkaline. Effervescence with acid ranges from none to slight.

Depth to the buried profile varies considerably, and the buried soil varies in color, texture, and thickness of horizons. In many places the B2b horizon is lacking and the Brownfield soil rests on the buried calcium carbonate horizon. This buried soil appears to have been affected by a high water table or a wetter condition at some time; it is mottled and contains ferromanganese concretions. Also, the calcium carbonate horizon appears to have been enriched with calcium from ground water. Texture of this buried soil ranges from clay loam to sandy clay.

DRAKE SERIES

This series consists of shallow, light-gray to grayish-brown, well-drained, high-lime soils. They have developed from eolian material deposited during the late Wisconsin stage of the Pleistocene epoch. Probably this material was part of the Tahoka formation. The Drake soils are immature. They have formed under a cover of short grass on subdued dunes on the lee side (east and southeast) of playas or depressions. They occur as many small areas in most parts of the county. The total acreage is not large.

The Drake soils differ from the Arch soils in having no calcium carbonate horizon and in having steeper slopes. They differ from the Portales soils in being shallower and lighter in color.

The following profile of Drake soils is located 0.1 mile west of the northeastern corner of Section 10, Block Z. The slope is about 4 percent.

A1—0 to 6 inches, light brownish-gray (10YR 6/2) fine sandy loam; grayish brown (10YR 5/2) when moist; weak, granular structure; soft when dry, very friable when moist; very strongly calcareous; clear boundary.

AC—6 to 13 inches, pale-brown (10YR 6/3) loam; brown (10YR 5/3) when moist; weak, granular structure; slightly hard when dry, friable when moist; many fine pores; very strongly calcareous; gradual boundary.

C—13 to 48 inches +, light-gray (10YR 7/2) loam; light brownish gray (10YR 6/2) when moist; very strongly calcareous.

Thickness of the A1 horizon varies from 4 to 12 inches; the thinnest spots are on the crest of the dunes. Texture ranges from loam to loamy fine sand but is generally fine sandy loam. Color varies from light gray to grayish

brown; it is lightest on the crest of the dunes and becomes darker toward the lee side and on the lesser slopes.

Thickness of the AC horizon ranges from 5 to 15 inches. Texture varies from heavy fine sandy loam to light clay loam. Color ranges from pale brown to light gray.

The C horizon is usually several feet thick, loam or light clay loam in texture, and light gray or white in color.

The slope range is 1 to 8 percent.

GOMEZ SERIES

This series comprises moderately deep, brown to grayish-brown, well-drained sandy soils. They have developed from unconsolidated, sandy, calcareous sediments deposited late in the Pleistocene epoch. These sediments seem to have had a shallow water table before the present soils developed. The Gomez soils have formed under a cover of tall grass in nearly level, slightly depressed areas. They are minor in extent and are mapped only as part of an undifferentiated group with Portales loamy fine sand. Most of the acreage is in the southern part of the county.

The Gomez soils are more sandy than the Portales and are deeper and more sandy than the Arch soils.

The following profile of Gomez loamy fine sand is located at the northeastern corner of Labor 12, League 134. A profile of Gomez loamy fine sand is shown in figure 23.

A1—0 to 18 inches, brown (10YR 5/3) loamy fine sand; brown (10YR 4/3) when moist; single grain; loose when dry or moist; mildly alkaline; gradual boundary.

AC—18 to 30 inches, pale-brown (10YR 6/3) light fine sandy loam; brown (10YR 5/3) when moist; weak, granular structure; slightly hard when dry, very friable when moist; many fine and medium pores; common fine concretions of $CaCO_3$; strongly calcareous; clear boundary.

Cca—30 to 44 inches, white (2.5Y 8/2) fine sandy loam; light gray (2.5Y 7/2) when moist; consistence same as for AC horizon; about 30 percent of $CaCO_3$ equivalent, 10 percent of which is fine concretions; very strongly calcareous; gradual boundary.

C—44 to 72 inches +, light brownish-gray (2.5Y 6/2) loamy fine sand; grayish brown (2.5Y 5/2) when moist; loose when dry or moist; few concretions of $CaCO_3$; strongly calcareous.

Thickness of the A1 horizon ranges from 10 to 30 inches. Color varies from brown to grayish brown and in cultivated areas to pale brown or light brown (values 4 to 6 dry, chromas 2 to 4, hues 7.5YR and 10YR). Texture ranges from loamy fine sand to fine sand. Reaction ranges from mildly alkaline to moderately alkaline. Effervescence with acid ranges from none to slight.

Thickness of the AC horizon ranges from 8 to 20 inches. Color varies from brown to pale brown or light brownish gray. Texture ranges from loamy fine sand to fine sandy loam; the clay content generally is less than 15 percent. Structure varies from weak granular to single grain. Effervescence with acid ranges from slight to strong.

Depth to the Cca horizon ranges from 20 to 40 inches. Thickness of this horizon varies from 10 to 25 inches. Color ranges from white to light gray or very pale brown (values 7 and 8 dry, chromas 1 to 3, hues 10YR to 2.5Y). Content of $CaCO_3$ ranges from 20 to 50 percent.

Texture of the C horizon ranges from light fine sandy loam to loamy fine sand. Color varies from light gray or white to very pale brown or olive gray (values 5 to 8 dry, chromas 1 to 3, hues 10YR to 5Y). The lower values are in hue 5Y. Content of $CaCO_3$ is much less than in the Cca horizon.

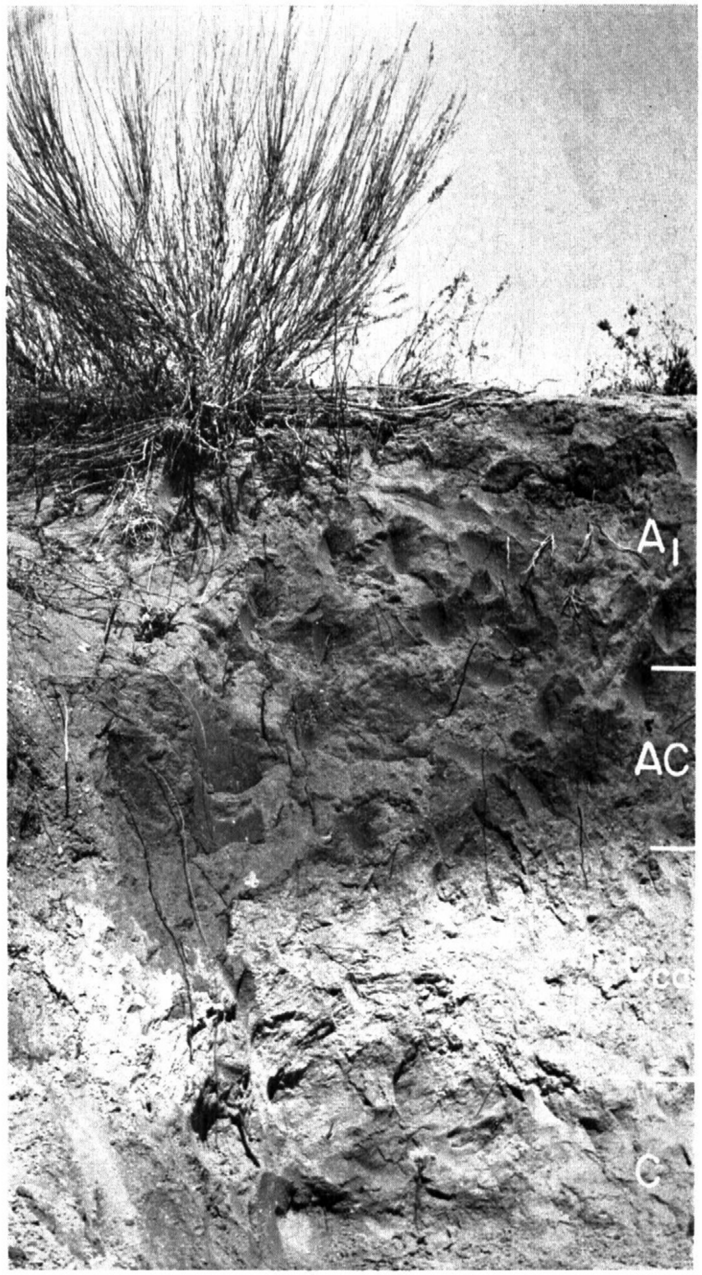

Figure 23.—Profile of Gomez loamy fine sand.

KIMBROUGH SERIES

This series comprises very shallow, brown, well-drained soils of the uplands. They have developed in thick beds of indurated, platy, stonelike caliche. The Kimbrough soils have formed under a cover of short grass. They are nearly level to gently sloping. They are inextensive and occur in the northern part of the county.

The Kimbrough soils are much shallower and less red than the Arvana soils. They are less clayey and much shallower than the Stegall soils. They differ from the Potter soils in having indurated caliche within 10 inches of the surface.

The following profile of a Kimbrough soil is located 0.1 mile east and 0.1 mile south of the northwestern corner of Section 11, Block V.

A1—0 to 6 inches, brown (7.5YR 4/2) loam; dark brown (7.5YR 3/2) when moist; weak, granular structure; slightly hard when dry, friable when moist; few to common, fine and very fine pores; few, fine to medium, hard concretions of $CaCO_3$; mildly alkaline; abrupt boundary.

Dr—6 to 24 inches +, indurated platy caliche.

Thickness ranges from 2 to 10 inches. Color varies from brown to dark grayish brown (hues 7.5YR and 10YR). Texture ranges from loam to fine sandy loam. Effervescence with acid ranges from none to strong.

The rocklike caliche layer is usually 1 to 2 feet thick over softer, more massive caliche that is many feet thick. The hardened caliche consists of indurated plates or slabs 8 to 15 inches in diameter and 2 to 3 inches thick. These plates are smooth on top, knobby or concretionary beneath, and laminated within. They overlap from 20 to 50 percent.

LUBBOCK SERIES

This series consists of deep, dark-brown to dark grayish-brown, slowly permeable but well-drained soils in slight depressions. They have developed from unconsolidated, moderately fine textured sediments deposited in the Pleistocene epoch. The Lubbock soils have formed under a cover of short grass. They are very minor in extent and occur in the northern part of the county.

The Lubbock soils are less clayey and better drained than the Randall soils. They are more clayey than the Zita soils and darker colored and more clayey than the Amarillo.

The following profile of Lubbock fine sandy loam is located 2 miles west and 2 miles north of Morton, 330 yards west and 50 feet south of the northeast corner of Labor 2, League 119.

A1p—0 to 5 inches, dark-brown (7.5YR 4/2) fine sandy loam; dark brown (7.5YR 3/2) when moist; structureless; slightly hard when dry, very friable when moist; mildly alkaline; abrupt boundary.

A12—5 to 10 inches, dark-brown (7.5YR 3/2) fine sandy loam; very dark brown (7.5YR 2/2) when moist; compound structure—weak coarse prismatic and granular; consistence same as for A1p; many fine pores and worm casts; mildy alkaline; clear boundary.

B1—10 to 20 inches, very dark grayish-brown (10YR 3/2) clay loam; very dark brown (10YR 2/2) when moist; moderate, medium, subangular blocky structure; hard when dry, friable when moist; many very fine pores and worm casts; mildly alkaline; clear boundary.

B2—20 to 32 inches, gray (10YR 5/1) light clay; dark gray (10YR 4/1) when moist; moderate, fine, blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; few very fine pores; mildly alkaline; clear boundary.

B3—32 to 38 inches, gray (5Y 6/1) heavy clay loam; gray (5Y 5/1) when moist; weak, subangular blocky structure; hard when dry, friable when moist; few very fine pores; few fine, soft masses of $CaCO_3$; strongly calcareous; clear boundary.

Cca—38 to 60 inches, white (2.5Y 8/2) clay loam; light gray (2.5Y 7/2) when moist; estimated 40 percent by volume of $CaCO_3$ equivalent, 10 percent of which is hard, medium to fine concretions; very strongly calcareous; diffuse boundary.

C—60 to 74 inches +, pink (7.5YR 8/4) clay loam; pink (7.5YR 7/4) when moist; about 15 to 20 percent by volume of $CaCO_3$ equivalent; very strongly calcareous.

Thickness of the A horizon ranges from 8 to 14 inches. Color varies from dark brown to dark grayish brown (hues 7.5YR and 10YR). Texture of the fine sandy loams ranges from light to heavy fine sandy loam. Texture of the clay loams ranges from heavy loam to clay loam. Reaction ranges from neutral to mildly alkaline.

Thickness of the B1 horizon varies from 6 to 12 inches. Color ranges from dark grayish brown to very dark grayish brown. Texture varies from light clay loam to heavy clay loam.

Thickness of the B2 horizon ranges from 8 to 14 inches. Color varies from gray to very dark grayish brown. Texture ranges from heavy clay loam to clay. Structure varies from moderate medium to moderate fine blocky. Reaction ranges from neutral to mildly alkaline.

Thickness of the B3 horizon is usually less than 8 inches. Color varies from light gray to gray or grayish brown. Structure is weak and ranges from subangular blocky to granular. Effervescence with acid ranges from slight to very strong.

Depth to the Cca horizon ranges from 36 to 48 inches. Thickness of this horizon varies from 12 to 36 inches. Color ranges from light gray to white or even from pink to very pale brown (values 7 to 8 dry, chromas 2 to 4, hues 7.5YR to 2.5Y). Calcium carbonate may make up 30 to 60 percent of the Cca horizon.

The C horizon contains much less $CaCO_3$ than the Cca. It is generally pink or very pale brown or even reddish yellow. The parent material seems to be similar to that of the Zita and Amarillo soils, which are closely associated with the Lubbock soils.

MANSKER SERIES

This series consists of shallow, grayish-brown to brown, well-drained, calcareous soils of the uplands. They have developed from unconsolidated, strongly calcareous, medium-textured to moderately fine textured sediments of the Pleistocene epoch. The Mansker soils have formed under a cover of mid and short grasses. They are nearly level to moderately sloping. They are inextensive but occur in most parts of the county.

The Mansker soils are less deep than the Portales soils, darker colored than the Arch soils, and deeper than the Potter soils. They have a prominent calcium carbonate horizon, which the Berthoud soils lack.

The following profile of Mansker fine sandy loam is located in a gently sloping area 1.3 miles south and 0.5 mile east of Morton, 0.25 mile south of the northwest corner of Labor 34, League 102.

A1p—0 to 6 inches, brown (10YR 5/3) fine sandy loam; dark brown (10YR 3/3) when moist; structureless; soft when dry, very friable when moist; many fine to medium concretions of $CaCO_3$ on surface; strongly calcareous; abrupt boundary.

AC—6 to 15 inches, pale-brown (10YR 6/3) sandy clay loam; brown (10YR 5/3) when moist; compound structure—weak coarse prismatic and granular; slightly hard when dry, friable when moist; many fine pores and worm casts; few fine concretions of $CaCO_3$; strongly calcareous; clear boundary.

Cca—15 to 32 inches, very pale brown (10YR 8/3) clay loam; pale brown (10YR 6/3) when moist; hard when dry, friable when moist; many fine to medium concretions of $CaCO_3$; about 30 percent by volume of $CaCO_3$ equivalent; very strongly calcareous; diffuse boundary.

C—32 to 48 inches +, pink (7.5YR 8/4) light clay loam; light brown (7.5YR 6/4) when moist; many moderately cemented caliche rocks less than 8 inches in diameter make up this horizon; very strongly calcareous.

Thickness of the surface layer ranges from 6 to 10 inches. Color varies from brown to grayish brown (hues 7.5YR to 10YR). Texture ranges from fine sandy loam to loam. In the virgin condition the structure is weak granular.

Thickness of the AC horizon ranges from 6 to 12 inches. Color varies from grayish brown to pale brown. Texture of the fine sandy loams ranges to sandy clay loam; texture of the loams ranges to light clay loam.

Depth to the Cca horizon ranges from 10 to 20 inches. Thickness of this horizon ranges from 6 to 24 inches; the horizon is thinnest where the slope is steepest. Color ranges from very pale brown to white and, in places, to pink. Content of $CaCO_3$ varies from 30 to 50 percent. In places this horizon is strongly cemented.

The C horizon has about the same characteristics as the Cca horizon, except that it contains less $CaCO_3$.

This soil is porous and generally has many worm cavities. Calcium carbonate concretions are common throughout the profile.

PORTALES SERIES

This series comprises moderately deep, grayish-brown to brown, well-drained, calcareous soils. They have developed from limy plains sediments deposited late in the Pleistocene epoch and apparently calcified by a shallow water table prior to the development of the present soil. The Portales soils have formed under a cover of mid and short grasses. They are nearly level to gently sloping and are slightly lower than surrounding upland soils. They are extensive but occur chiefly in the northern half of the county.

The Portales soils are darker colored and deeper than the Arch soils. They are deeper than the Mansker soils and lighter colored and more calcareous than the Zita soils. They have a prominent calcium carbonate horizon, which the Drake soils lack. The Portales soils are calcareous and are grayer than the Amarillo and Arvana soils. They are more clayey in the subsoil than the Gomez soils.

The following profile of Portales fine sandy loam is located 1 mile east and 1 mile north of Morton, 0.2 mile west of the northeast corner of Labor 14, League 103.

A1p—0 to 8 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) when moist; structureless; soft when dry, very friable when moist; strongly calcareous; abrupt boundary.

A12—8 to 15 inches, dark-brown (10YR 4/3) light sandy clay loam; dark brown (10YR 3/3) when moist; weak, coarse, prismatic and granular structure; slightly hard when dry, friable when moist; many fine to medium pores and worm casts; strongly calcareous; gradual boundary.

AC—15 to 28 inches, pale-brown (10YR 6/3) sandy clay loam; brown (10YR 5/3) when moist; weak, granular structure; slightly hard when dry, friable when moist; many fine pores, common worm casts; very strongly calcareous; clear boundary.

Cca—28 to 46 inches, white (10YR 8/2) clay loam; light gray (10YR 7/2) when moist; about 40 to 50 percent by volume of $CaCO_3$ equivalent, both hard and soft concretions of fine to medium size; very strongly calcareous; diffuse boundary.

C—46 to 60 inches +, very pale brown (10YR 7/3) clay loam; pale brown (10YR 6/3) when moist; very strongly calcareous but contains much less $CaCO_3$ than Cca horizon.

Thickness of the A1p horizon generally ranges from 6 to 10 inches but may be greater in the loamy fine sand. Color ranges from brown to dark grayish brown; the loams have the darker colors. Texture varies from loamy fine sand to loam. In undisturbed profiles, structure of the A11 horizon is weak granular.

Thickness of the A12 horizon varies from 5 to 12 inches. Color range is the same as for the A1p. Texture ranges from fine sandy loam to light clay loam.

Thickness of the AC horizon ranges from 10 to 20 inches. Color varies from pale brown to grayish brown. Texture ranges from sandy clay loam to clay loam.

Depth to the Cca horizon ranges from 20 to 40 inches. Thickness of this horizon varies from 12 to 36 inches. Color ranges from white to pale brown or, in places, pink (hues 7.5YR to 10YR). The content of $CaCO_3$ ranges from 40 to 60 percent.

The C horizon ranges in color from light gray to very pale brown. The $CaCO_3$ content is less than half that of the Cca horizon.

This soil generally has many pores and worm casts. Hard, medium to fine concretions of $CaCO_3$ may occur throughout the profile. In places the Cca horizon may be moderately cemented.

POTTER SERIES

This series consists of very shallow, pale-brown to grayish-brown, calcareous, sloping soils. They have developed from thick beds of soft or weakly cemented material that is usually more than 50 percent $CaCO_3$. The Potter soils have formed along draw slopes under a sparse cover of mid and short grasses. The slope range is 1 to 12 percent, but slopes of 3 to 8 percent predominate. These soils are minor in extent. They occur mostly along Sulphur Draw.

The Potter soils differ from the Kimbrough soils in lacking a layer of indurated caliche. They are shallower than the Mansker and Berthoud soils.

The following profile of Potter soils is located 2.6 miles south of the intersection of Farm Roads 301 and 1780, 0.2 mile north of the southeastern corner of Labor 20, League 53.

A1—0 to 8 inches, pale-brown (10YR 6/3) fine sandy loam; brown (10YR 5/3) when moist; weak, granular structure; slightly hard when dry, very friable when moist; common, fine and medium concretions of $CaCO_3$ on surface and in soil; strongly calcareous; clear boundary.

C—8 to 40 inches +, pink (7.5YR 7/4) loam that becomes clay loam below a depth of 20 inches; light brown (7.5YR 6/4) when moist; more than 50 percent of mass consists of concretions that are hard in uppermost 10 inches and become softer with depth; very strongly calcareous.

Thickness of the A1 horizon ranges from 2 to 10 inches. Color varies from light brown to pale brown or grayish brown (values 5 and 6 dry, chromas 2 to 4, hues 7.5YR to 10YR). Texture ranges from fine sandy loam to loam. Caliche gravel is common on the surface and in the soil.

Color of the C horizon ranges from white to pink. Hard concretions or caliche rocks are usually small but range up to 8 inches in diameter.

RANDALL SERIES

In this series are deep, dark-colored, poorly drained soils of the playas. They have developed under very wet conditions from unconsolidated, fine-textured, late Pleistocene sediments. The Randall soils have formed under a cover of sedges, annual weeds, herbs, and, in places, short grass. They occur as many small areas. The total acreage is small.

The Randall soils have a more clayey subsoil and are more poorly drained than the Lubbock soils. They are much more clayey than the Zita soils and are less clayey and less red than the Amarillo soils.

The following profile of Randall clay is located in a 10-acre lake 1.5 miles north and 2.5 miles east of Morton, 0.15 mile south of the northeast corner of Labor 3, League 103.

A1p—0 to 8 inches, dark grayish-brown (10YR 4/2) clay; very dark grayish brown (10YR 3/2) when moist; structureless; very hard when dry, firm when moist; very sticky and plastic when wet; neutral; abrupt boundary.

A12—8 to 25 inches, very dark gray (10YR 3/1) clay; black (10YR 2/1) when moist; weak to moderate, medium and fine, blocky structure; extremely hard when dry, very firm when moist; very sticky and plastic when wet; few very fine pores; neutral; gradual boundary.

AC—25 to 36 inches, dark-gray (10YR 4/1) clay; very dark gray (10YR 3/1) when moist; massive; consistence same as for A12; few fine, hard, ferromanganese concretions; mildly alkaline; diffuse boundary.

C—36 to 60 inches +, gray (10YR 5/1) clay; dark gray (10YR 4/1) when moist; structure, consistence, and special features same as for AC horizon; weakly calcareous.

Total thickness of the A horizons ranges from 10 to 30 inches. A few inches of overwash of other textures is common in the Randall clays. Texture of the fine sandy loams ranges from loamy fine sand to loam. This sandy material was relatively recently deposited. In the Randall clays, color of the A horizon ranges from gray to very dark grayish brown (values 3 to 5 dry, chromas 1 or 2, hues 10YR to 2.5YR). In the Randall fine sandy loams, the color of the A horizon ranges to dark brown (hues 7.5YR). Structure of the A horizon varies from moderate or weak blocky to massive. Reaction ranges from neutral to moderately alkaline. Effervescence with acid ranges from none to strong.

Thickness of the AC horizon ranges from 10 to 30 inches. Color varies from gray to dark gray (hues 10YR to 2.5Y). Reaction ranges from neutral to moderately alkaline. Effervescence with acid ranges from none to strong.

Depth to the C horizon ranges from 30 to 60 inches. Color of this horizon varies from light gray to gray. Reaction ranges from neutral to moderately alkaline. Effervescence with acid ranges from none to strong.

Fine, hard concretions of ferromanganese are generally present in the lower horizons and in places occur throughout the profile. The C horizon is mottled with brown or yellow in a few places.

SPUR SERIES

This series comprises deep, nearly level, brown to dark-brown, well-drained, calcareous soils on bottom lands. They have developed from strongly calcareous, medium-textured to moderately fine textured recent alluvium transported from nearby slopes. The Spur soils have formed under a cover of mid and short grasses along the bottom of Sulphur Draw. They are very seldom overflowed. They are minor in extent and are mapped in an undifferentiated group with Bippus soils.

The Spur soils are lighter colored than the Bippus soils.

The following profile of Spur fine sandy loam is located about 0.7 mile southeast of a house in League 91, 12 miles south and 6 miles east of Lehman.

A1—0 to 15 inches, brown (7.5YR 5/4) fine sandy loam; dark brown (7.5YR 3/4) when moist; weak, granular structure; slightly hard when dry, very friable when moist; many fine and very fine pores; strongly calcareous; clear boundary.

AC—15 to 32 inches, brown (7.5YR 5/2) sandy clay loam; dark brown (7.5YR 4/2) when moist; weak, subangular blocky and granular structure; hard when dry, friable when moist; many fine and very fine pores; strongly calcareous; clear boundary.

C—32 to 60 inches +, light brownish-gray (10YR 6/2) sandy clay loam; grayish brown (10YR 5/2) when moist; hard when dry, friable when moist; very strongly calcareous; films and threads of $CaCO_3$ and few very fine concretions of $CaCO_3$; few very thin lenses of loamy fine sand below a depth of 50 inches.

Thickness of the A1 horizon ranges from 10 to 25 inches. Texture varies from fine sandy loam to light loam or light sandy clay loam in the fine sandy loams, and from loam to clay loam in the loams. Color of the A1 ranges from brown to dark brown to grayish brown (values of 4 to 5 dry, chromas 2 to 4, hues 7.5YR to 10YR).

Thickness of the AC horizon ranges from 12 to 30 inches. Texture varies from loam to clay loam and, in the fine sandy loams, to sandy clay loam. Color range is the same as for the A1 horizon.

The C horizon has the same texture range as the AC horizon except that it has lenses of coarser textured material in places, mostly in the lower part of the horizon. Color varies from light gray to brown to very pale brown (values 5 to 7 dry, chromas 2 to 3, hues 7.5YR to 10YR).

STEGALL SERIES

This series consists of shallow to moderately deep, nearly level, dark-brown, well-drained soils of the uplands. They have developed from a thin mantle of moderately fine textured, unconsolidated, calcareous plains sediments over hard, platy, stonelike caliche. The Stegall soils have formed under a cover of short grass. They are minor in extent and occur only in the northern part of the county.

The Stegall soils differ from the Kimbrough soils in being deeper and more clayey and occurring in slightly lower positions. They are more clayey and less red than the Arvana soils. They are more clayey than the Mansker soils and contain less calcium.

The following profile of Stegall loam is located 5 miles north and 6 miles east of Morton, 400 feet west and 150 feet north of the southeast corner of Section 8, Block V.

A1p—0 to 7 inches, dark-brown (10YR 4/3) loam; dark brown (10YR 3/3) when moist; structureless; hard when dry, friable when moist; neutral; abrupt boundary.

B21—7 to 12 inches, dark-brown (7.5YR 4/2) clay loam; dark brown (7.5YR 3/2) when moist; compound structure—weak or moderate medium blocky or subangular blocky; very hard when dry, firm when moist; common fine pores and worm casts; mildly alkaline; gradual boundary.

B22—12 to 22 inches, dark-brown (7.5YR 4/2) heavy clay loam; dark brown (7.5YR 3/2) when moist; compound

structure—moderate medium or fine blocky or subangular blocky; consistence same as for B21 horizon; few to common, fine and very fine pores; mildly alkaline; clear boundary.

B3—22 to 26 inches, brown (10YR 5/3) clay loam; dark brown (10YR 4/3) when moist; compound structure—weak subangular blocky and granular; hard when dry, friable when moist; many fine pores; strongly calcareous; abrupt boundary.

Drca—26 to 36 inches +, indurated platy caliche.

Thickness of the A horizon ranges from 4 to 10 inches. Texture varies from loam to light clay loam. Color ranges from brown to dark grayish brown (values 4 and 5 dry, chromas 2 and 3, hues 7.5YR to 10YR). In the virgin condition the structure of the A horizon is weak granular. Reaction ranges from neutral to mildly alkaline.

Thickness of the B21 horizon ranges from 3 to 8 inches. In shallow places, this horizon may be lacking. Color is the same as for the A horizon. Texture varies from light clay loam to heavy clay loam. Structure ranges from weak to moderate in strength, from fine to medium in size, and from blocky to subangular blocky in type. Reaction is the same as for the A horizon.

Thickness of the B22 horizon ranges from 8 to 14 inches. Color ranges from reddish brown to dark grayish brown (values 3 to 4 dry, chromas 2 to 4, hues 5YR to 10YR). The redder colors are in the shallow phases. Texture varies from medium clay loam to heavy clay loam; it is heavier than the texture of the B21 or B3. Structure and reaction are the same as for the B21 horizon.

Thickness of the B3 horizon ranges from 3 to 8 inches. In the shallow phases, this horizon may be lacking. Color varies from reddish brown to brown. Effervescence with acid ranges from slight to strong.

Depth to the Drca horizon ranges from 10 to 36 inches. Areas where the depth is less than 20 inches are classed as shallow phases. The Drca is usually 1 to 2 feet thick over softer caliche that is many feet thick. The hardened caliche consists of indurated plates or slabs 1 to 3 feet in diameter and 2 to 6 inches thick. These plates are smooth on top, knobby beneath, and laminated within. They overlap from 20 to 50 percent.

TIVOLI SERIES

This series consists of deep, light-colored, loose sands that have developed from eolian sands deposited during the Pleistocene epoch or more recently. The Tivoli soils have formed under a cover of tall grass on dunes 6 to 30 feet high. These dunes have short, choppy slopes of as much as 30 percent. These soils are extensive. They occur mostly in the southern and extreme western parts of the county, in close association with Brownfield fine sand.

The Tivoli soils differ from the Brownfield soils in being much sandier in the subsoil and in having dune topography.

The following profile of Tivoli fine sand is located about 1 mile southwest of Bledsoe.

A1—0 to 8 inches, brown (10YR 5/3) fine sand; brown (10YR 4/3) when moist; single grain; loose when dry or moist; neutral; clear boundary.

C—8 to 72 inches +, light yellowish-brown (10YR 6/4) fine sand; light yellowish brown (10YR 5.5/4) when moist; structure, consistence, and reaction same as for A1 horizon.

Thickness of the A1 horizon ranges from 4 to 10 inches. Color varies from brown to pale brown, light brown, or light yellowish brown. The darker colors generally are organic-matter stain. Reaction is neutral or mildly alkaline.

Color of the C horizon varies from light brown to yellow and from very pale brown to yellowish red (values 6 to 8 dry, chromas 3 to 6, hues 5YR to 10YR). Reaction is neutral or mildly alkaline. Small areas are weakly calcareous.

ZITA SERIES

This series comprises moderately deep, brown to dark grayish-brown, well-drained soils. They have developed from limy plains sediments deposited late in the Pleistocene epoch and apparently calcified by a shallow water table prior to the development of the present soil. The Zita soils have formed under a cover of mid and short grasses. They are nearly level to gently sloping and are slightly lower than surrounding upland soils. They occur mostly in the northern part of the county.

The Zita soils differ from the Portales soils in being noncalcareous in the A horizon. They are deeper than the Mansker soils. They are less red than the Amarillo soils and less clayey in the subsoil than the Lubbock and Randall.

The following profile of Zita fine sandy loam is located in a nearly level area 3 miles north of Bledsoe, 0.5 mile east and 0.1 mile north of the southwest corner of Section 18, Block U.

A11—0 to 10 inches, dark-brown (10YR 4/3) fine sandy loam; dark brown (10YR 3/3) when moist; weak, granular structure; soft when dry, very friable when moist; mildly alkaline; clear boundary.

A12—10 to 20 inches, dark-brown (10YR 4/3) light sandy clay loam; dark brown (10YR 3/3) when moist; compound structure—weak coarse prismatic and granular; hard when dry, friable when moist; many fine and medium pores and worm casts; mildly alkaline; clear boundary.

AC—20 to 26 inches, grayish-brown (10YR 5/2) clay loam; dark grayish-brown (10YR 4/2) when moist; weak, granular structure; consistence and special features same as for A12 horizon; strongly calcareous; clear boundary.

Cca—26 to 44 inches, white (10YR 8/2) clay loam; light brownish gray (10YR 6/2) when moist; about 40 percent $CaCO_3$, of which 10 percent is hard concretions; very strongly calcareous; diffuse boundary.

C—44 to 72 inches +, very pale brown (10YR 7/3) clay loam; pale brown (10YR 6/3) when moist; some pink (7.5YR 7/4) lumps; very strongly calcareous, but contains much less $CaCO_3$ than Cca horizon.

Thickness of the A11 horizon ranges from 6 to 12 inches. Color varies from dark brown to very dark grayish brown. Texture varies considerably. In the loams, it ranges to light clay loam, and in the fine sandy loams, to light sandy clay loam. Values range from 3 to 5 dry, chromas from 2 to 4, hues from 7.5YR to 10YR. Structure is weak and ranges from subangular blocky to granular and, in a few places, prismatic.

Thickness of the A12 horizon ranges from 6 to 14 inches. Color is the same as for the A11 horizon. Texture ranges from sandy clay loam, in the fine sandy loams, to clay loam, in the loams. Structure is prismatic and subangular blocky or prismatic and granular.

Thickness of the AC horizon ranges from 4 to 12 inches. Color varies from grayish brown to pale brown. Texture ranges from sandy clay loam, in the fine sandy loams, to medium clay loam, in the loams.

Depth to the Cca horizon ranges from 20 to 36 inches. Thickness of this horizon varies from 10 to 40 inches. Color ranges from white to very pale brown or even pink (hues 7.5YR to 10YR). Content of $CaCO_3$ ranges from 30 to 60 percent.

The C horizon ranges in color from light gray to very pale brown. In many places the color grades to reddish yellow (5YR 6/6) and the texture to light clay loam below a depth of 60 inches. The $CaCO_3$ content of the C horizon is usually less than half that of the Cca horizon.

This soil is porous, and the uppermost 24 inches is commonly 20 to 40 percent worm casts.

General Nature of the County

Cochran County was formed from Young and Bexar Territories in 1876. It was organized in 1924. It was named in honor of Pvt. Robert Cochran, who died at the Alamo.

This county is a part of the region the Spaniards called Llano Estacado, which means staked plains. It was so called because rock stakes were set up at intervals as guides to watering places.

In 1870, thousands of buffalo roamed the area. Various tribes of Plains Indians hunted and camped in the area. Buffalo hunters arrived about 1874. The early ranchers came soon afterward. The population was only 25 in 1900. In 1960, it was 6,417.

In 1882, Texas gave 3 million acres of land, part of it in Cochran County, to the Capitol Land Syndicate. In return, the Syndicate was to erect the capitol building at Austin, Tex. This Capitol land was known as the XIT Ranch. The XIT began operations in this county in 1890.

Few changes took place until 1923, when farmers began to buy small tracts. After that, farming operations expanded rather rapidly. In 1959, there were 451 farms in the county. The average size was about 920 acres. Cotton and grain sorghum have been the main crops. Cotton was harvested from 72,905 acres in 1959, and grain sorghum from 120,333 acres. A total of 201,029 acres was used for crops in that year. Livestock in the county in 1959 included 8,363 cattle and calves, of which 407 were dairy cows; 3,795 hogs and pigs; and 19,755 chickens.

The first irrigation well in the county was dug in 1941. By 1959, irrigated cropland totaled 67,370 acres.

Geology

The outstanding event in the geologic history of Cochran County was the deposition of the Ogallala formation. This formation is the main source of irrigation water in the county. It was formed from materials deposited several million years ago, during the early part of the Pliocene epoch. To understand how this underground formation developed, it is necessary to review the geologic history of the area.

About 180 million years ago, shortly before the uplift of the Appalachian Mountains, a shallow sea covered the area that is now western Texas. Marine sediments that were deposited during this period formed the Permian Red Beds. These Red Beds do not outcrop in Cochran County. They are probably 2,000 feet below the surface and are several thousand feet thick. Most of the oil pumped in this county comes from these formations.

While the Appalachian Mountains were being formed, this area rose above the level of the sea. Streams that flowed over the exposed Permian rocks eroded fine-textured materials and redeposited them, during the Late Triassic epoch, along the flood plains. These materials formed the Triassic Red Beds. These sedimentary rocks are probably of the Dockum group. They do not outcrop in Cochran County but are encountered in oil wells and perhaps in a few water wells. The Triassic Red Beds average about 1,500 feet in thickness.

During the Cretaceous period, a shallow arm of the sea again partly covered the High Plains, including all of Cochran County. Sands, clays, and limestones were deposited over the area. These materials are of the Comanche series and probably include the Fredericksburg and Washita groups. The Kiamichi formation of the Fredericksburg group is encountered in water wells in the county. The Kiamichi is usually easily identified by the presence of bluish-black shale, although it contains lighter colored sands, gravels, and limestones also. The Duck Creek formation of the Washita group is relatively thin, and it is discontinuous in Cochran County. Much of it was probably washed away. It consists of brownish-yellow shale and light-gray to yellow limestone. It is thought that the contrast between the gray to bluish-black shale of the underlying Kiamichi formation and the lighter brownish-yellow shale of the Duck Creek formation is the result of change from a reducing environment during Kiamichi time to an oxidizing environment during Duck Creek time (*3*).

The formation of the Rocky Mountains was the next significant development. At the time these mountains reached their maximum height, rainfall was very heavy. Swift streams from the mountains cut valleys and canyons into the Cretaceous rock, much of which was washed away. These swift streams that flowed eastward down the mountain slopes carried a heavy load of silt, sand, and gravel. As they flowed onto the flat, treeless plain, they slowed abruptly, and large amounts of their sediments were deposited. These deposits formed alluvial fans of coarse gravelly material along the foot slopes of the mountains. Finer materials were transported and spread farther to the east. The Ogallala formation developed from these deposits of outwash more than a million years ago. In Cochran County, this formation ranges in thickness from less than 50 feet to nearly 300 feet. It is thickest in the valleys and canyons that were cut into the Cretaceous rocks.

The beds of sand and gravel in the lower part of the Ogallala became saturated with water from the Rocky Mountains while the formation was developing. Later, the formation was cut off from the Rocky Mountains and its source of water was blocked. Rain and snow are now the only sources of water to replenish the underground supply.

The water table slopes gently to the southeast, and the water moves very slowly. The natural flow is probably not more than 1 or 2 feet a day. Before wells were drilled for irrigation, the water was discharged mainly by springs along the caprock to the east at about the same rate it was replenished. At present, water is being pumped for irrigation much faster than it is being restored.

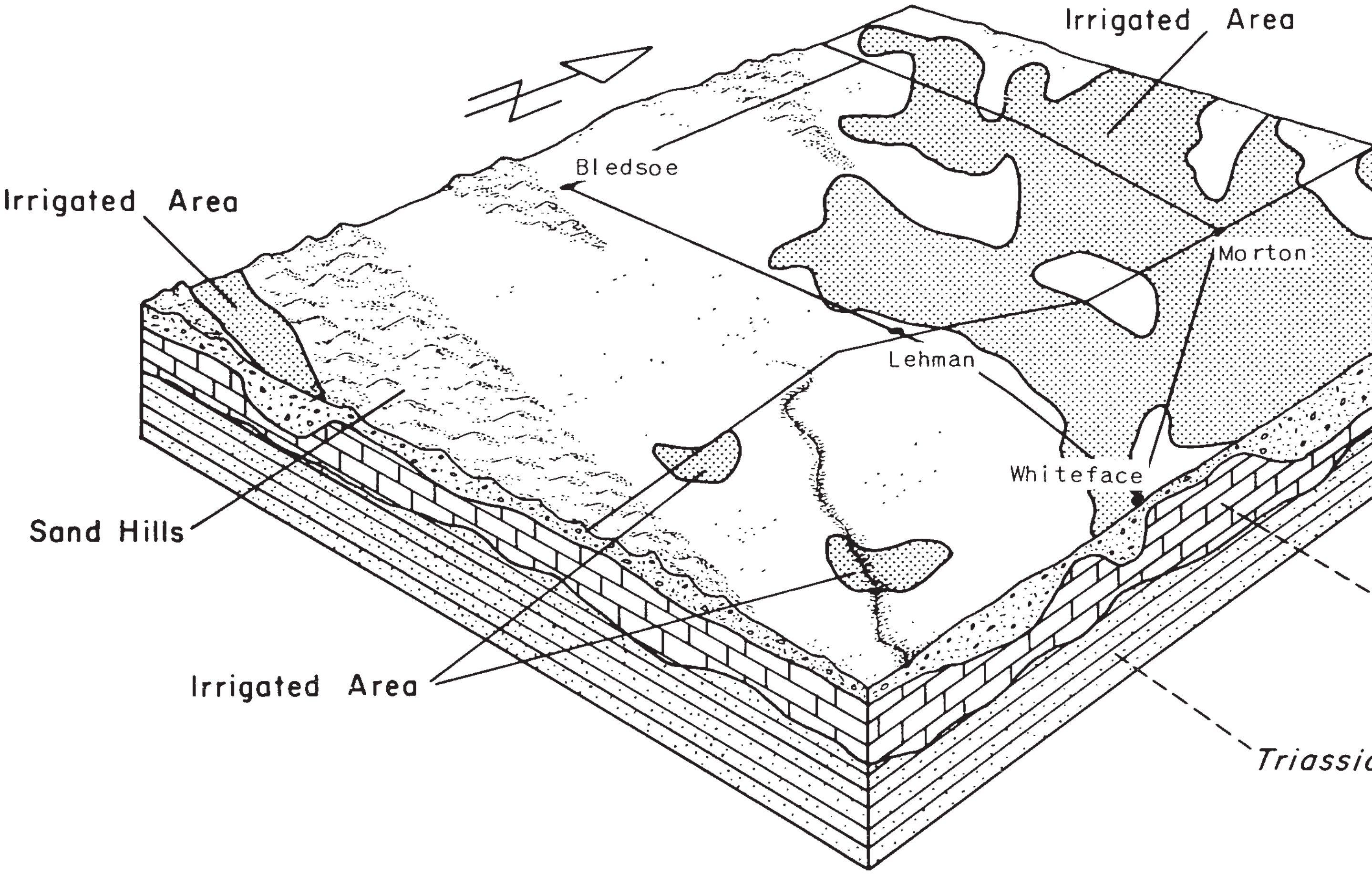

Figure 24.—Irrigated areas in Cochran County.

All well water for irrigation, industrial use, and domestic use is obtained from the Ogallala formation. Little water is obtained from the Cretaceous or Triassic rocks, and most of it is too high in mineral content to be suitable for domestic use or for irrigation. Where the depth to water is more than 100 feet and the Ogallala formation is thin, there is little or no water available for irrigation (fig. 24).

Climate [4]

Cochran County has the semiarid, warm, continental climate characteristic of the Southern High Plains. Wide variations in both temperature and rainfall are common.

Annual precipitation in Cochran County has varied from 8.09 inches in 1956, a drought year, to 23.66 inches in 1960. More than 80 percent of the annual rainfall occurs in the growing season (May through October). In July 1960, a total of 9.87 inches of rain fell. This is more than the yearly total for either 1952 or 1956. From September through April, there have occasionally been times when no measurable moisture fell for periods of 30 days or more.

Most of the rainfall occurs as the result of thunderstorms. Such storms are most frequent during the warmer months and during the afternoon and evening. Characteristically, thunderstorm rainfall is geographically spotty. Thus, one part of the county may receive a heavy downpour while other parts receive little or no rain. Heavy thundershowers sometimes result in excessive runoff and rapid erosion of cultivated land; consequently, rainfall statistics are not an accurate indication of actual benefits to crops and vegetation.

The average annual rainfall at Morton is believed to be nearly 17 inches, although the only available records, which cover a 17-year period, show it to be 14.83 inches. The average at Lubbock, Tex., based on a 50-year record, is about 18.9 inches, and that at Portales, N. Mex., based on a 40-year record is about 18 inches. Lubbock is about 55 miles east of Morton and is at an elevation of 3,243 feet. Portales is about 50 miles northwest of Morton and is at an elevation of 4,004 feet. The average annual rainfall at Morton is less than has been recorded at the county seats of surrounding counties.

Wintertime precipitation falls as both snow and rain. Snowfalls are generally light, and the snow remains on the ground only a short time. Exceptionally heavy snowfalls have occurred, such as the 14-inch fall in February 1956, and the 10-inch fall in a 24-hour period on February 20, 1961. Because of the disproportionate effect of these rare heavy snowfalls, data on average monthly snowfall are misleading.

Temperature, like rainfall, varies over a wide range, from season to season and often from day to day. From November through March, cold fronts, or "northers," are frequent, but the cold spells are usually of short duration. Warmer temperatures return when the wind shifts from north to southwest. In summer, cold fronts lie well to the north of the region, and the temperature is less changeable. Summer days are hot, but low humidity and good wind circulation over the nearly flat terrain modify the effect of the high temperatures. Night temperatures in summer are generally in the 60's.

There is no place in Cochran County where official records of precipitation and temperature have been kept continuously for a significant period of time. Table 5 gives monthly and annual precipitation and temperatures at Portales, N. Mex., which is about 50 miles northwest of Morton and 246 feet higher in elevation. Data from the Weather Bureau station at Portales are considered to be representative of the climate in Cochran County.

The terrain offers little resistance to the wind; consequently, the average wind speed is high, compared with that in central and eastern Texas. The strongest continuous winds occur during February, March, and April. They result from intense low-pressure centers that originate on the high plains just east of the Rocky Mountains. These winds often produce severe duststorms during drought years. Winds associated with severe thunderstorms late in spring and early in summer reach higher speeds but are of short duration and are less damaging to the soils than the sustained winds associated with the low-pressure centers.

Damaging hailstorms may occur any time from spring planting time to fall harvest. They are most likely to occur late in spring and early in summer. Ordinarily, hailstorms affect relatively small areas.

Relative humidity is generally low. It is highest in the early morning hours, when it may be expected to average between 65 and 75 percent. Relative humidity is lowest during the warmest part of the afternoon, when it may be expected to average between 30 and 40 percent. Sunshine is abundant the year around. Cloudy days are infrequent and are most likely to occur during the winter and early in spring. Evaporation is high. The average is approximately 103 inches annually from Weather Bureau evaporation pans and approximately 70 inches annually from lakes. Approximately 66 percent of the pan evaporation occurs during the period May through October.

Freeze data for Cochran County have been estimated from isopleths of late spring and early fall low temperatures (*2*).

The average date of the last occurrence of a 32° temperature in spring is April 15, and the average date of the first occurrence of a 32° temperature in fall is October 27. Thus, the average freeze-free season is 194 days in length. There is a 20 percent chance of a freezing temperature later than April 28 in spring and earlier than October 20 in fall. There is a 5 percent chance of a freezing temperature later than May 4 in spring and earlier than October 10 in fall. The average number of days between the last occurrence of a temperature of 28° in spring and the first occurrence in fall is 215.

Natural Resources

Soils and oil are the greatest natural resources in Cochran County. The original product of the soils, good grass, attracted the first cattle ranchers. The natural fertility of soils that developed under grass provided good yields of cotton, grain sorghum, and other products and encouraged agricultural development.

[4] By R. D. Blood, State climatologist, U.S. Weather Bureau, Austin, Tex.

TABLE 5.--TEMPERATURE AND PRECIPITATION AT PORTALES, N. MEX.

[Elevation, 4,004 feet]

Month	Temperature 1/			Precipitation 2/			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1917)	Wettest year (1941)	Average snowfall
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
January	36.4	80	-18	0.38	0.58	0.31	2.2
February	41.2	83	-28	.39	.08	.09	1.8
March	47.6	92	-4	.73	.02	3.01	1.4
April	56.7	98	11	1.14	.21	1.60	.4
May	65.5	102	25	2.53	1.19	12.05	.1
June	74.1	109	33	2.54	(3/)	7.45	(3/)
July	77.1	107	50	2.84	1.19	3.62	(3/)
August	75.9	105	40	2.66	3.77	2.29	(3/)
September	69.0	104	31	2.29	.38	7.66	0
October	58.6	94	15	1.37	(3/)	5.20	.2
November	45.9	90	0	.55	.02	.33	1.1
December	37.7	77	-9	.65	(3/)	.49	2.7
Year	57.1	109	-28	18.07	7.40	44.10	9.9

1/ Average temperature based on a 32-year record, through 1955; highest and lowest temperatures on a 40-year record, through 1952.

2/ Average precipitation based on a 36-year record, through 1955; wettest and driest years based on a 45-year record, in the period 1905-1955; snowfall based on a 41-year record, through 1952.

3/ Trace.

The first oil well was drilled in 1936. Between then and August 31, 1958, a total of 112,065,983 barrels was produced.

Irrigation water is also an important natural resource. The first irrigation well was dug in 1941. Irrigation has steadily increased since World War II and at present about 1,200 wells are providing irrigation water for more than 65,000 acres.

The only game birds now common in the county are blue quail, bobwhite quail, and doves. Migratory ducks, geese, and sandhill cranes are plentiful in the fall and winter. A few antelopes and prairie chickens are on the ranches in the southern part of the county.

Public Facilities and Farm Improvements

High schools are located at Bledsoe, Morton, and Whiteface. Girlstown, U.S.A., which is located south of Whiteface, is a home for homeless and unfortunate girls. The girls in this home are a few months to 18 years of age. The county has churches of most denominations.

All rural sections have electricity. About 30 percent of the farms had telephones in 1959.

Farm dwellings are generally well kept. Farm equipment is also kept in good repair. In 1959, there were 950 tractors on 400 farms.

Industries

Much of the industry in Cochran County is connected with agriculture. There are 14 cotton gins in the county. There are also two cotton warehouses, one cotton-seed delinting plant, nine grain storage elevators, six commercial cattle-feeding lots, four dairies, and one meatpacking plant.

In the southern half of the county are many producing oil wells. A liquid petroleum refinery is located south of Lehman. Caliche is mined from open pits (fig. 25), to be used for building and maintaining local roads.

Figure 25.—**Wall of a caliche pit, showing the thick bed of material, below the soil, that is mined and used in construction.**

Transportation

The railroads and highways meet the needs of agriculture and industry. According to the 1959 Census of Agriculture, only 30 percent of the farms are more than 1 mile from a paved road, and only 3 farms are 5 or more miles from a paved road. All roads are well maintained.

State Highways 116, 125, and 214 are important roads in the county. The Santa Fe Railway has a spur line, built in 1925, from Bledsoe, Lehman, and Whiteface to Lubbock. Motortruck and buslines on the highways connect the county to all parts of the State and to New Mexico.

Literature Cited

(1) American Association of State Highway Officials.
1961. standard specifications for highway materials and methods of sampling and testing. Ed. 8, 2 v., 401 and 617 p., illus.

(2) Blood, R. D. and Hildreth, R. J.
1958. late spring and early fall low temperatures in texas. MP-298, Texas Agr. Expt. Sta.—Texas Agr. Ext. Serv. 12 p., illus.

(3) Brand, J. P.
1953. cretaceous of the llano estacado of texas. Univ. Texas Bur. Econ. Geol. Rept. of Inv.—No. 20, 59 p., illus.

(4) Chepil, W. S., Woodruff, N. P., and Zingg, A. W.
1955. field study of wind erosion in western texas. U.S. Dept. Agr. SCS-TP-125, 59 p., illus.

(5) Evans, G. L. and Meade, G. E.
1945. quaternary of the texas high plains. Univ. Texas Pub. 4401, p. 485-507.

(6) Frye, John C. and Leonard, A. Byron.
1957. studies of cenozoic geology along eastern margin of texas high plains, armstrong to howard counties. Univ. Texas Bur. Econ. Geol. Rept. of Inv.—No. 32, 62 p., illus.

(7) Waterways Experiment Station, Corps of Engineers.
1953. the unified soil classification system. Tech. Memo. No. 3-357, 3 v.

Glossary

Aggregate (of soil). Many fine soil particles held in a single mass or cluster, such as a clod, crumb, block, or prism. Many properties of the aggregate differ from those of an equal mass of unaggregated soil.

Alkaline soil. Generally, a soil that is alkaline throughout most or all of the part occupied by plant roots. Precisely, any soil having a pH value greater than 7.0; practically, a soil having a pH above 7.3.

Alluvium. Fine material, such as sand, silt, or clay, that has been deposited on land by streams.

Base saturation. The degree to which a material is saturated with exchangeable cations other than hydrogen, expressed as a percentage of the cation-exchange capacity.

Calcareous soil. Soil that contains enough calcium carbonate to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. Soil that is alkaline in reaction because of the presence of free calcium carbonate. The pH is usually more than 7.8.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. It may consist of soft thin layers in the soil; or it may consist of hard, thick beds just beneath the solum; or it may be exposed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay that has been deposited on the surface of a soil aggregate.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the foot of slopes.

Concretions. Hard grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds that cement the soil grains together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose. Noncoherent; will not hold together in a mass.

Friable. When moist, crushes easily under gentle to moderate pressure between thumb and forefinger and can be pressed together into a lump.

Firm. When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic. When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a wire when rolled between thumb and forefinger.

Sticky. When wet, adheres to other material; tends to stretch somewhat and pull apart, rather than pull free from other material.

Hard. When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft. When dry, breaks into powder or individual grains under very slight pressure.

Cemented. Hard and brittle, little affected by moistening.

Deflocculate. To separate, or break up, soil aggregates into the individual particles; to disperse the particles of a granulated clay to form a clay that runs together, or puddles.

Dispersion, soil. Deflocculation of the soil and suspension of particles in water.

Eolian deposits. Material accumulated through wind action; commonly refers to sandy material in dunes.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. The relative position of the several soil horizons in a typical soil profile, and their nomenclature, are as follows:

A0. Organic debris, partly decomposed or matted.

A1. A dark-colored horizon having a fairly high content of organic matter mixed with mineral matter.

A2. A light-colored horizon, often representing the zone of maximum leaching where podzolized; absent in wet, dark-colored soils.

A3. Transitional to B horizon but more like A than B; lacking in places.

B1. Transitional to B horizon but more like B than A; lacking in places.

B2. A generally darker colored horizon that often represents the zone of maximum illuviation where podzolized.

B3. Transitional to C horizon.

C. Slightly weathered parent material; lacking in some soils.

D. Underlying substratum.
The A horizons make up a zone of eluviation, or a leached zone.
The B horizons make up a zone of illuviation, in which clay and other materials have accumulated. The A and B horizons, taken together are called the solum, or the true soil.

Indurated. Very strongly cemented. In Cochran County, term refers to rocklike caliche.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour.

Liquid limit. The moisture content at which a soil passes from a plastic to a liquid state.

Loam. Soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Parent material. The weathered rock or partly weathered soil from which a soil has formed; horizon C in the soil profile.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *Very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

pH. A numerical means of designating relatively weak acidity and alkalinity, as in soils and other biological systems. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Phase, soil. A subdivision of a soil type, series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil type, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects management.

Plasticity index. The numerical difference between liquid limit and plastic limit; the range in moisture content within which a soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Playas. Undrained basins that are generally dry but contain water for periods following rains.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values or in words, as follows:

	pH		*pH*
Extremely acid	below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Saline soil. A soil that contains enough soluble salts to impair growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual rock or mineral fragments 0.05 to 2.0 millimeters in diameter. Most sand grains are quartz, but sand may be of any mineral composition. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils that developed from a particular type of parent material and that have genetic horizons that, except for texture of the surface soil, are similar in differentiating characteristics and in arrangement in the profile.

Silt. Individual mineral particles 0.002 millimeter to 0.05 millimeter in diameter. As a textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by relief, over a period of time.

Solum. The upper part of the soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soils includes the A and B horizons.

Structure. The arrangement of primary soil particles into compound particles, or clusters, that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular.* Structureless soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. (See also Clay, Sand, and Silt.) The basic textural classes, in order of increasing proportions of fine particles, are as follows: sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse" or "very fine."

Type, soil. A subdivision of the soil series made on the basis of differences in the texture of the surface layer.

GUIDE TO MAPPING UNITS

[See table 1, page 8, for acreage and proportionate extent of soils; see table 2, page 36, for estimates of average yields of the major crops; see table 3, page 42, and table 4, page 52, for engineering properties of the soils]

Map symbol	Mapping unit	Page	Capability unit: Nonirrigated Symbol	Nonirrigated Page	Irrigated Symbol	Irrigated Page	Range site: Name	Range site: Page
AfA	Amarillo fine sandy loam, 0 to 1 percent slopes	9	IIIe-1	27	IIe-2	31	Mixed Land	38
AfB	Amarillo fine sandy loam, 1 to 3 percent slopes	9	IIIe-1	27	IIIe-2	32	Mixed Land	38
AfC	Amarillo fine sandy loam, 3 to 5 percent slopes	9	IVe-1	28	IVe-1	34	Mixed Land	38
AlA	Amarillo loam, 0 to 1 percent slopes	9	IIIce-1	26	IIe-1	31	Deep Hardland	38
AlB	Amarillo loam, 1 to 2 percent slopes	9	IIIe-2	27	IIIe-1	32	Deep Hardland	38
AmB	Amarillo loamy fine sand, 0 to 3 percent slopes	10	IVe-2	28	IIIe-5	33	Sandy Land	37
An	Arch fine sandy loam	10	IVes-1	29	IIIes-1	34	High Lime	39
Ao	Arch loam	10	IVes-1	29	IIIes-1	34	High Lime	39
AvA	Arvana fine sandy loam, 0 to 1 percent slopes	11	IIIe-1	27	IIe-2	31	Mixed Land	38
AvB	Arvana fine sandy loam, 1 to 3 percent slopes	11	IIIe-1	27	IIIe-2	32	Mixed Land	38
AwA	Arvana fine sandy loam, shallow, 0 to 1 percent slopes	11	IVe-4	29	IIIe-7	33	Mixed Land	38
Be	Berthoud-Potter complex	12						
	Berthoud soil	--	VIe-3	30	(None)	--	Mixed Plains	39
	Potter soil	--	VIe-3	30	(None)	--	Shallow Land	39
Bp	Bippus and Spur soils	12						
	Bippus soil	--	IIIe-1	27	IIe-2	31	Mixed Land	38
	Spur soil	--	IIIe-1	27	IIe-2	31	Mixed Plains	39
Br	Brownfield fine sand, thick surface	13	VIe-2	30	IVe-3	34	Deep Sand	38
Bs	Brownfield fine sand, thin surface	13	IVe-3	29	IIIe-6	33	Sandy Land	37
Bt3	Brownfield soils, severely eroded	13	VIe-2	30	(None)	--	Deep Sand	38
Bv	Brownfield-Tivoli fine sands	13	VIIe-1	30	(None)	--	Deep Sand	38
DrB	Drake soils, 1 to 3 percent slopes	14	IVes-1	29	IIIes-1	34	High Lime	39
DrC	Drake soils, 3 to 5 percent slopes	14	VIe-1	30	IVe-2	34	High Lime	39
DrD	Drake soils, 5 to 8 percent slopes	14	VIe-1	30	(None)	--	High Lime	39
Go	Gomez and Portales soils	14	IVe-2	28	IVe-3	34	Sandy Land	37
Km	Kimbrough soils	15	VIIs-1	30	(None)	--	Shallow Land	39
Lu	Lubbock fine sandy loam	15	IIIe-1	27	IIe-2	31	Mixed Land	38
Lv	Lubbock clay loam	15	IIIce-1	26	IIe-1	31	Deep Hardland	38
MfA	Mansker fine sandy loam, 0 to 1 percent slopes	16	IVe-4	29	IIIe-7	33	Mixed Plains	39
MfB	Mansker fine sandy loam, 1 to 3 percent slopes	16	IVe-4	29	IIIe-7	33	Mixed Plains	39
MkA	Mansker loam, 0 to 1 percent slopes	16	IVe-4	29	IIIe-7	33	Mixed Plains	39
MkB	Mansker loam, 1 to 3 percent slopes	16	IVe-4	29	IIIe-7	33	Mixed Plains	39
PfA	Portales fine sandy loam, 0 to 1 percent slopes	17	IIIe-3	28	IIe-4	32	Mixed Plains	39
PfB	Portales fine sandy loam, 1 to 3 percent slopes	17	IIIe-3	28	IIIe-4	33	Mixed Plains	39
PmA	Portales loam, 0 to 1 percent slopes	17	IIIce-2	27	IIe-3	31	Mixed Plains	39
PmB	Portales loam, 1 to 3 percent slopes	17	IIIe-4	28	IIIe-3	32	Mixed Plains	39
Ra	Randall soils	18	VIw-1	30	(None)	--	(None)	--
Rf	Randall fine sandy loam, thick surface variant	18	IVw-1	29	IVw-1	34	(None)	--
StA	Stegall loam, 0 to 1 percent slopes	19	IIIce-1	26	IIe-1	31	Deep Hardland	38
SwA	Stegall loam, shallow, 0 to 1 percent slopes	19	IVe-4	29	IIIe-7	33	Deep Hardland	38

GUIDE TO MAPPING UNITS--CONTINUED

Map symbol	Mapping unit	Page	Capability unit: Nonirrigated Symbol	Nonirrigated Page	Irrigated Symbol	Irrigated Page	Range site Name	Range site Page
Tv	Tivoli fine sand	19	VIIe-1	30	(None)	--	Deep Sand	38
Tx	Tivoli-Potter complex	19	VIIe-1	30	(None)	--	Sandy Land	37
ZfA	Zita fine sandy loam, 0 to 1 percent slopes	20	IIIe-1	27	IIe-2	31	Mixed Land	38
ZfB	Zita fine sandy loam, 1 to 3 percent slopes	20	IIIe-1	27	IIIe-2	32	Mixed Land	38
ZmA	Zita loam, 0 to 1 percent slopes	20	IIIce-1	26	IIe-1	31	Deep Hardland	38

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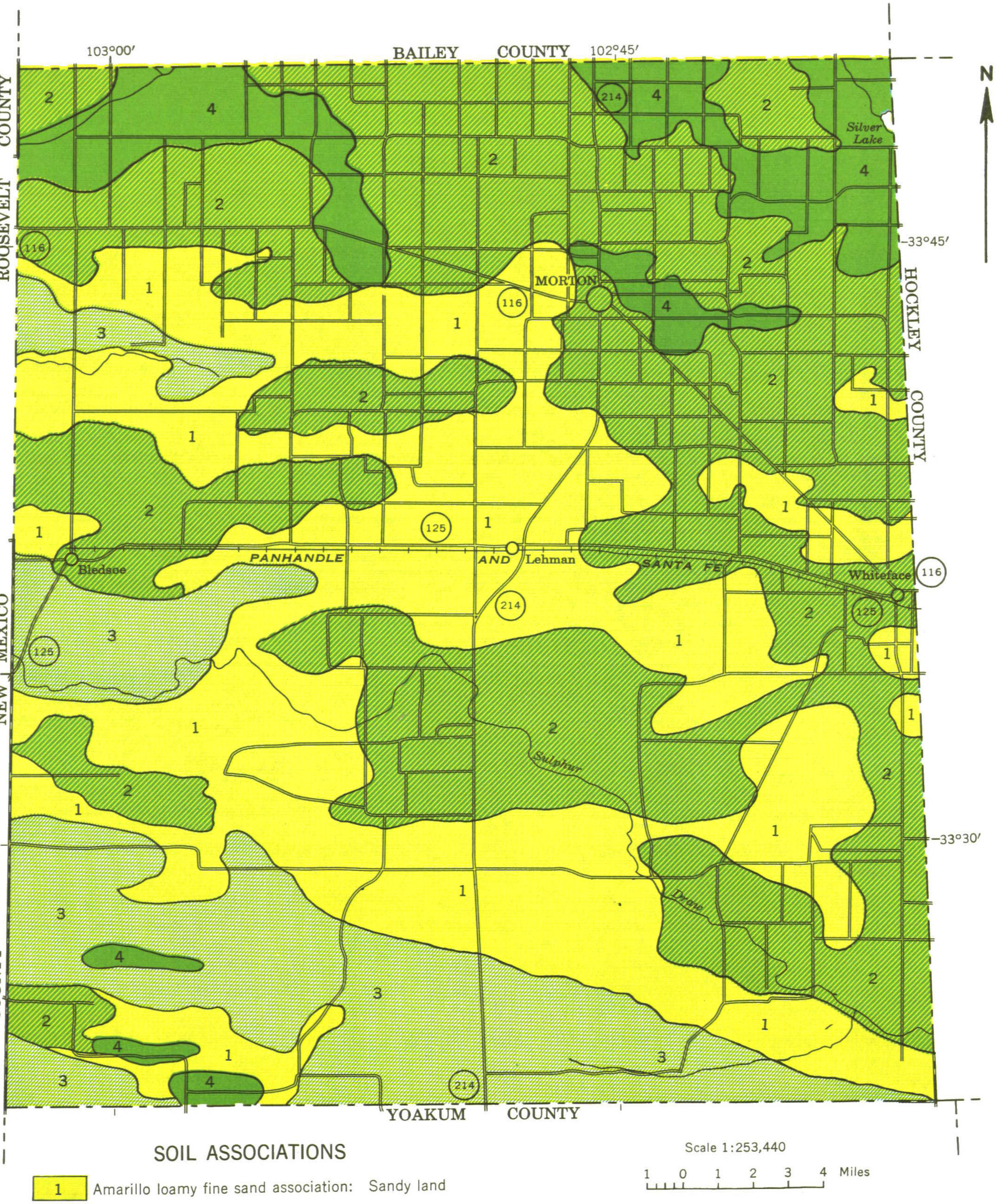
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEXAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
COCHRAN COUNTY, TEXAS



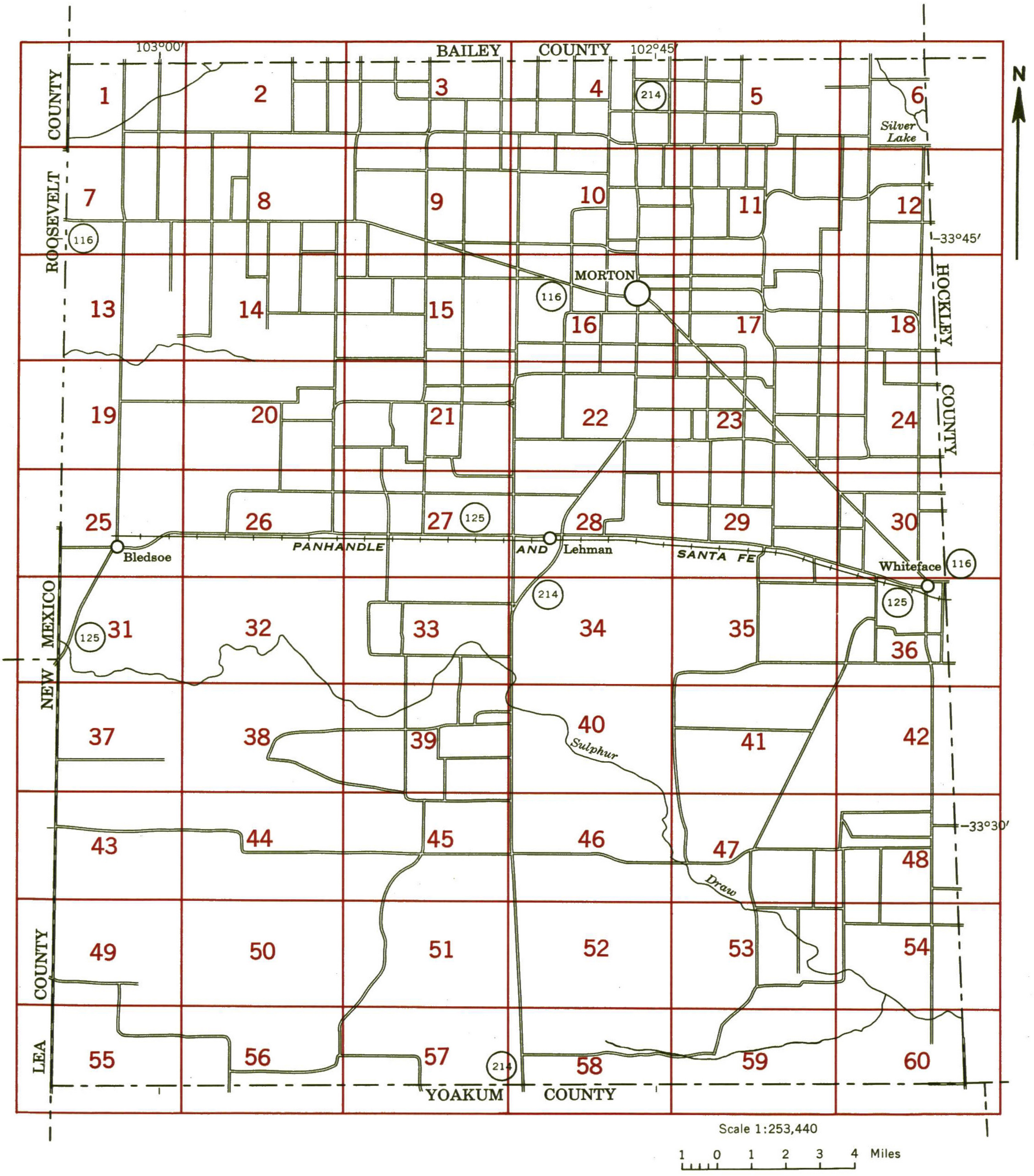
SOIL ASSOCIATIONS

1	Amarillo loamy fine sand association: Sandy land
2	Amarillo fine sandy loam association: Mixed land
3	Brownfield-Tivoli fine sand association: Deep sands
4	Portales-Zita association: Calcareous soils

March 1963

INDEX TO MAP SHEETS

COCHRAN COUNTY, TEXAS



SOIL LEGEND

The first capital letter is the initial one of the soil series name. A second capital letter, A, B, C, or D, shows the slope. Most symbols without a slope letter are those of nearly level soils, such as Lubbock clay loam, but some are for soils that have a considerable range of slope, such as the Berthoud-Potter complex. (W) following the soil name indicates that signs of erosion, especially of local shifting of soil by wind, are evident in some places, but the degree of erosion cannot be estimated reliably.

SYMBOL	NAME
AfA	Amarillo fine sandy loam, 0 to 1 percent slopes
AfB	Amarillo fine sandy loam, 1 to 3 percent slopes
AfC	Amarillo fine sandy loam, 3 to 5 percent slopes
AlA	Amarillo loam, 0 to 1 percent slopes
AlB	Amarillo loam, 1 to 2 percent slopes
AmB	Amarillo loamy fine sand, 0 to 3 percent slopes (W)
An	Arch fine sandy loam (W)
Ao	Arch loam (W)
AvA	Arvana fine sandy loam, 0 to 1 percent slopes
AvB	Arvana fine sandy loam, 1 to 3 percent slopes
AwA	Arvana fine sandy loam, shallow, 0 to 1 percent slopes
Be	Berthoud-Potter complex (W)
Bp	Bippus and Spur soils
Br	Brownfield fine sand, thick surface (W)
Bs	Brownfield fine sand, thin surface (W)
Bt3	Brownfield soils, severely eroded
Bv	Brownfield-Tivoli fine sands (W)
DrB	Drake soils, 1 to 3 percent slopes (W)
DrC	Drake soils, 3 to 5 percent slopes (W)
DrD	Drake soils, 5 to 8 percent slopes (W)
Go	Gomez and Portales soils (W)
Km	Kimbrough soils
Lu	Lubbock fine sandy loam
Lv	Lubbock clay loam
MfA	Mansker fine sandy loam, 0 to 1 percent slopes (W)
MfB	Mansker fine sandy loam, 1 to 3 percent slopes (W)
MkA	Mansker loam, 0 to 1 percent slopes
MkB	Mansker loam, 1 to 3 percent slopes
PfA	Portales fine sandy loam, 0 to 1 percent slopes
PfB	Portales fine sandy loam, 1 to 3 percent slopes
PmA	Portales loam, 0 to 1 percent slopes
PmB	Portales loam, 1 to 3 percent slopes
Ra	Randall soils
Rf	Randall fine sandy loam, thick surface variant
StA	Stegall loam, 0 to 1 percent slopes
SwA	Stegall loam, shallow, 0 to 1 percent slopes
Tv	Tivoli fine sand (W)
Tx	Tivoli-Potter complex (W)
ZfA	Zita fine sandy loam, 0 to 1 percent slopes
ZfB	Zita fine sandy loam, 1 to 3 percent slopes
ZmA	Zita loam, 0 to 1 percent slopes

Soil map constructed 1963 by Cartographic Division, Soil Conservation Service, USDA, from 1957 aerial photographs. Controlled mosaic based on Texas plane coordinate system, north central zone, Lambert conformal conic projection, 1927 North American datum.

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail, foot
- Railroad
- Ferries
- Ford
- Grade
- R. R. over
- R. R. under
- Tunnel

Buildings
- School
- Church
- Station

Mines and Quarries
- Mine dump
- Caliche pit

Power lines

Pipe lines

Cemeteries

Dams

Levees

Tanks

Cotton gin

Windmills

BOUNDARIES

- National or state
- County
- Township, U. S.
- Section line, corner
- Reservation
- Land grant

DRAINAGE

Streams
- Perennial
- Intermittent, unclass.

Canals and ditches — CANAL, DITCH

Lakes and ponds
- Perennial
- Intermittent

Wells — flowing

Springs

Marsh

Wet spot

RELIEF

Escarpments
- Bedrock
- Other

Prominent peaks

Depressions (Large / Small)
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

- Soil boundary and symbol — Dx
- Gravel
- Stones
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gullies

1

N

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Land division corners and numbers shown on this map are indefinite

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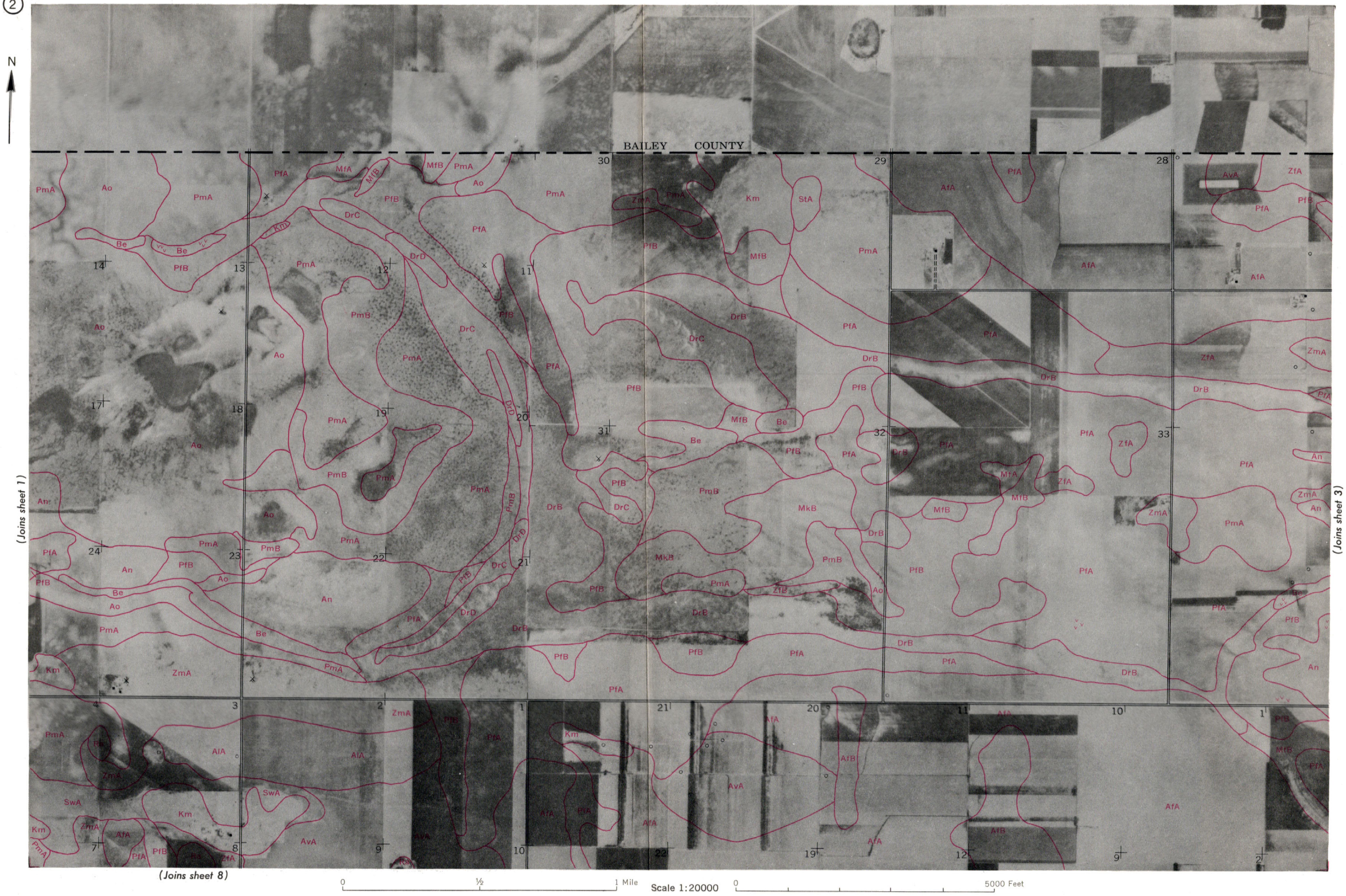
COCHRAN COUNTY, TEXAS—SHEET NUMBER 2

2



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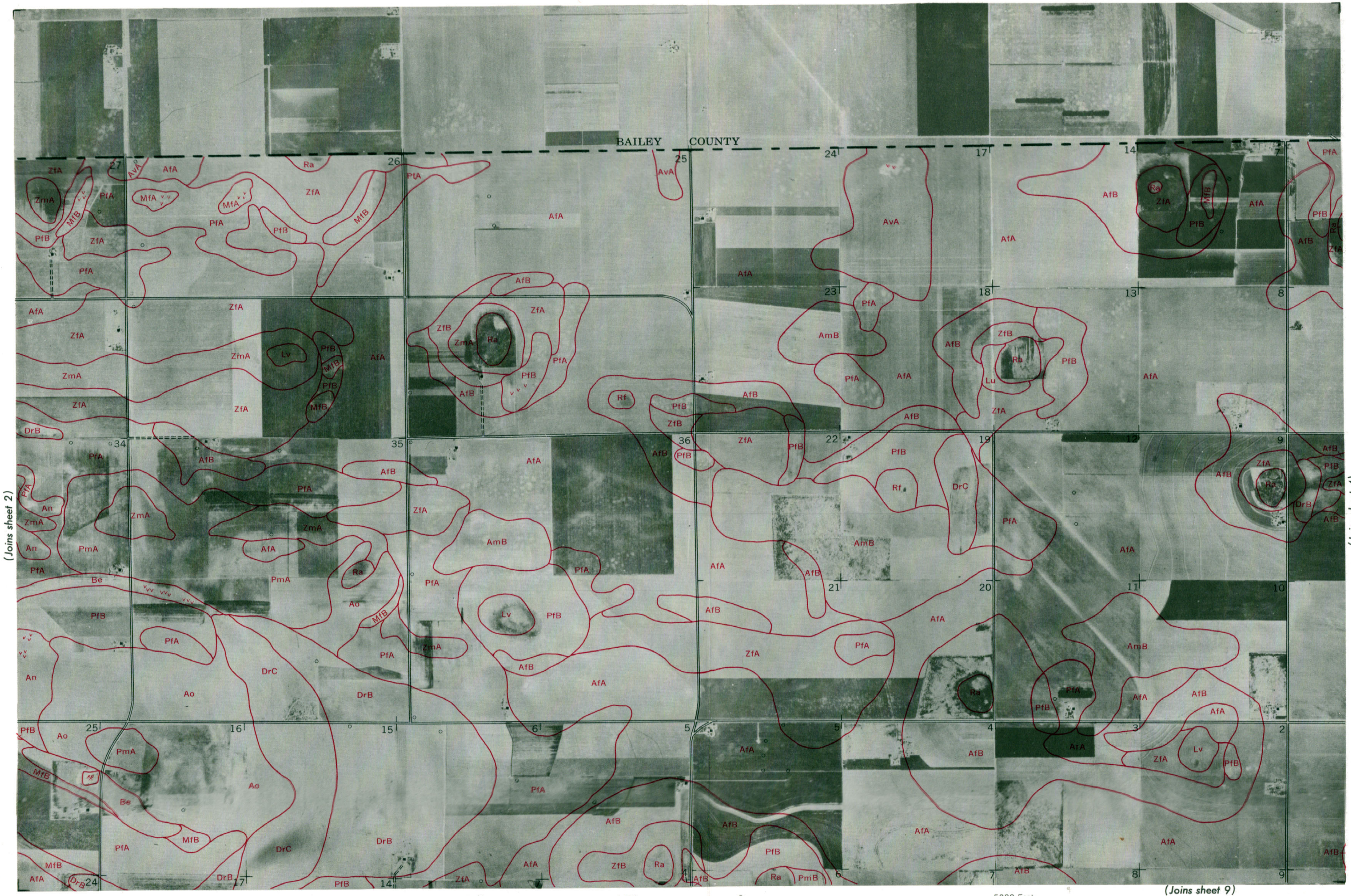

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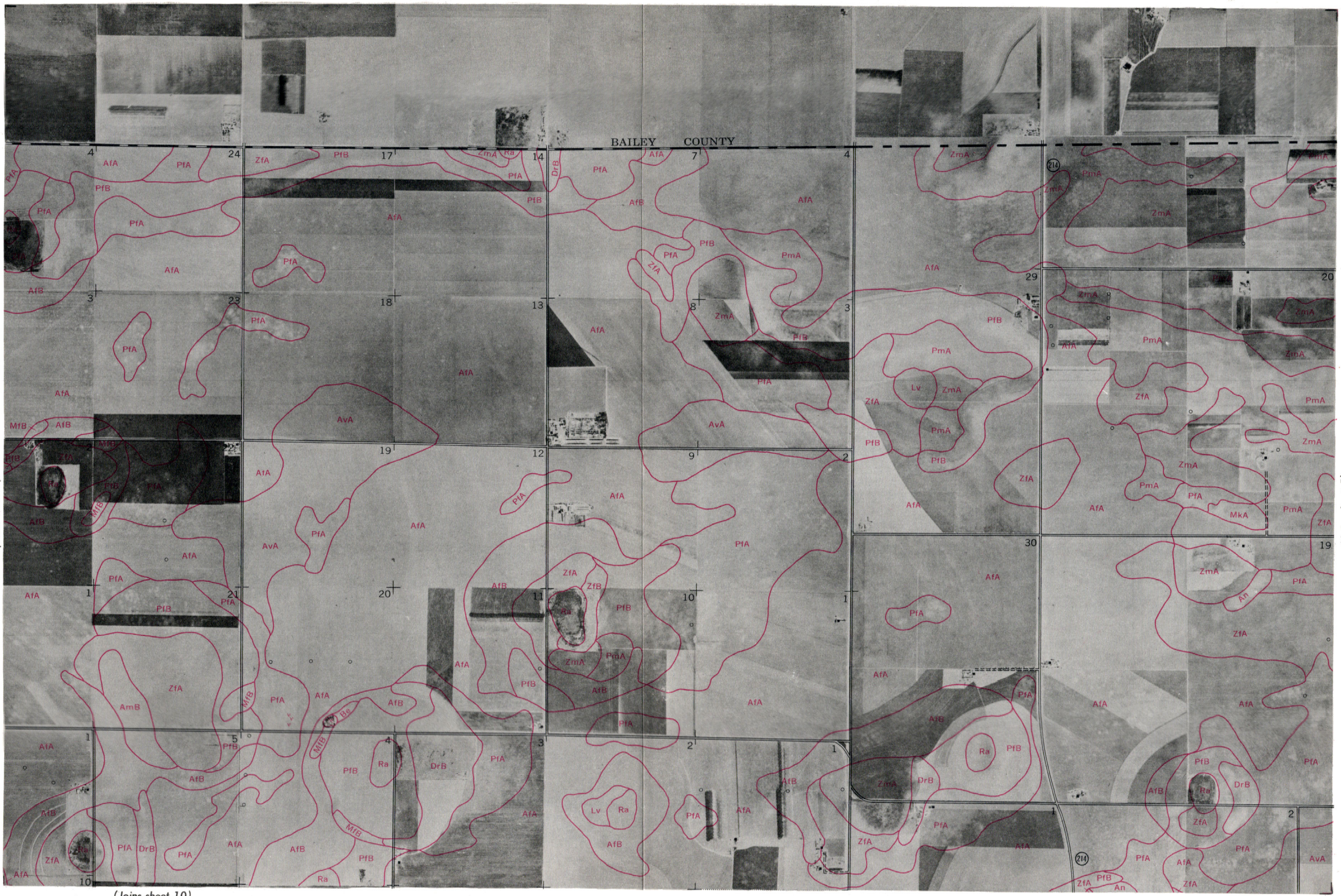

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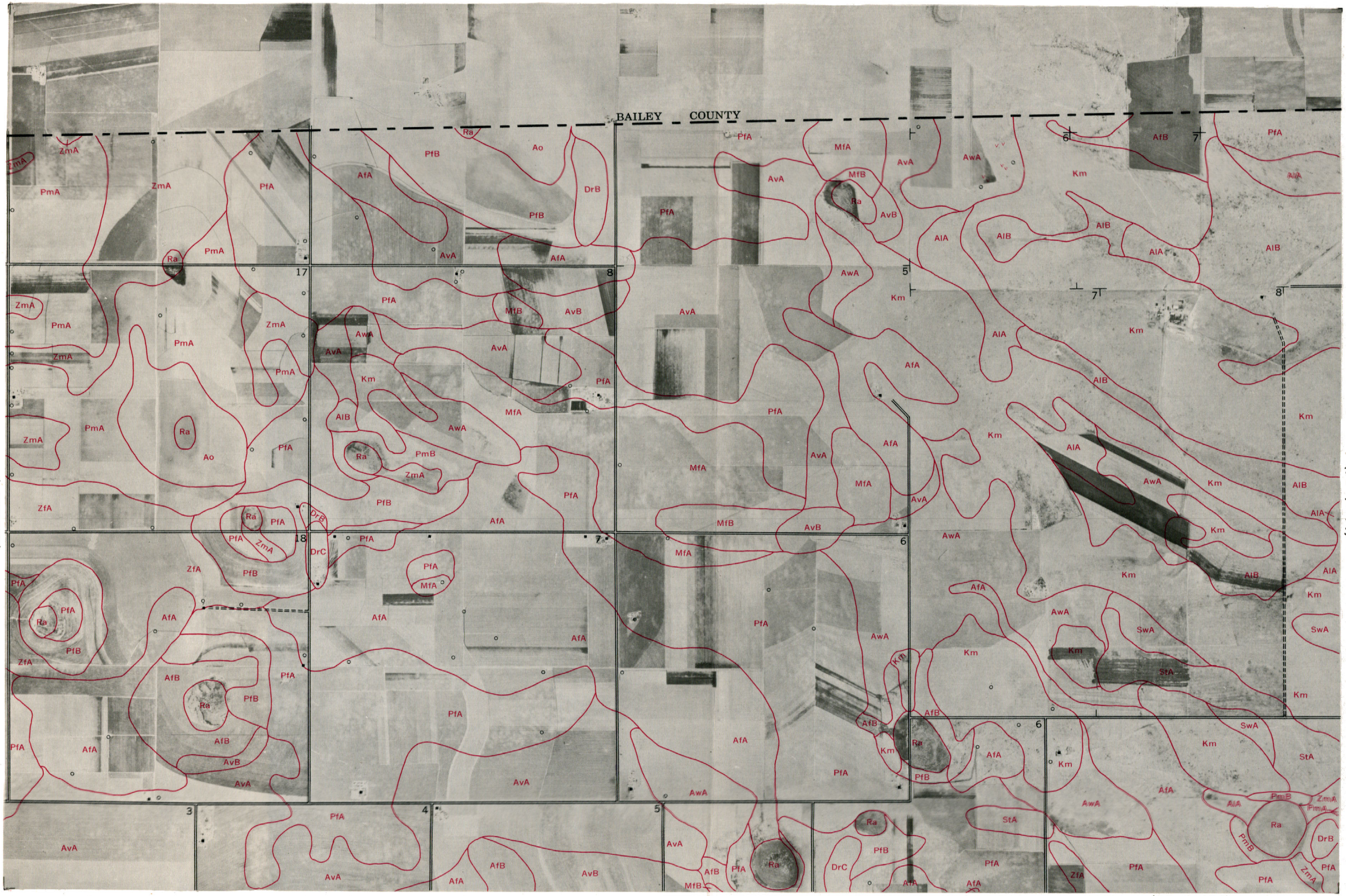

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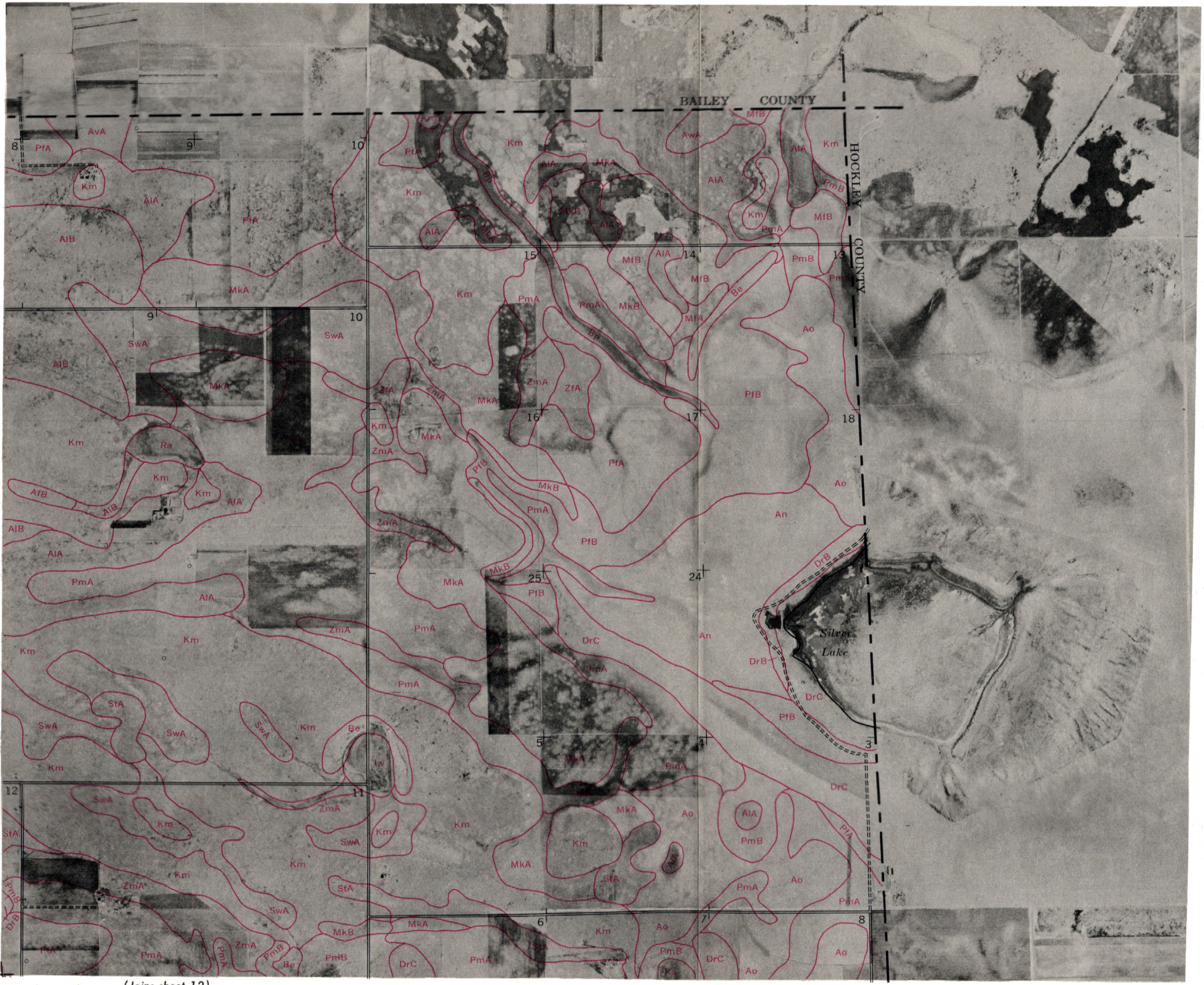

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7

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COCHRAN COUNTY, TEXAS—SHEET NUMBER 8

(Joins sheet 2)

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0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

COCHRAN COUNTY, TEXAS—SHEET NUMBER 9

(Joins sheet 3)

9

N

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COCHRAN COUNTY, TEXAS—SHEET NUMBER 10

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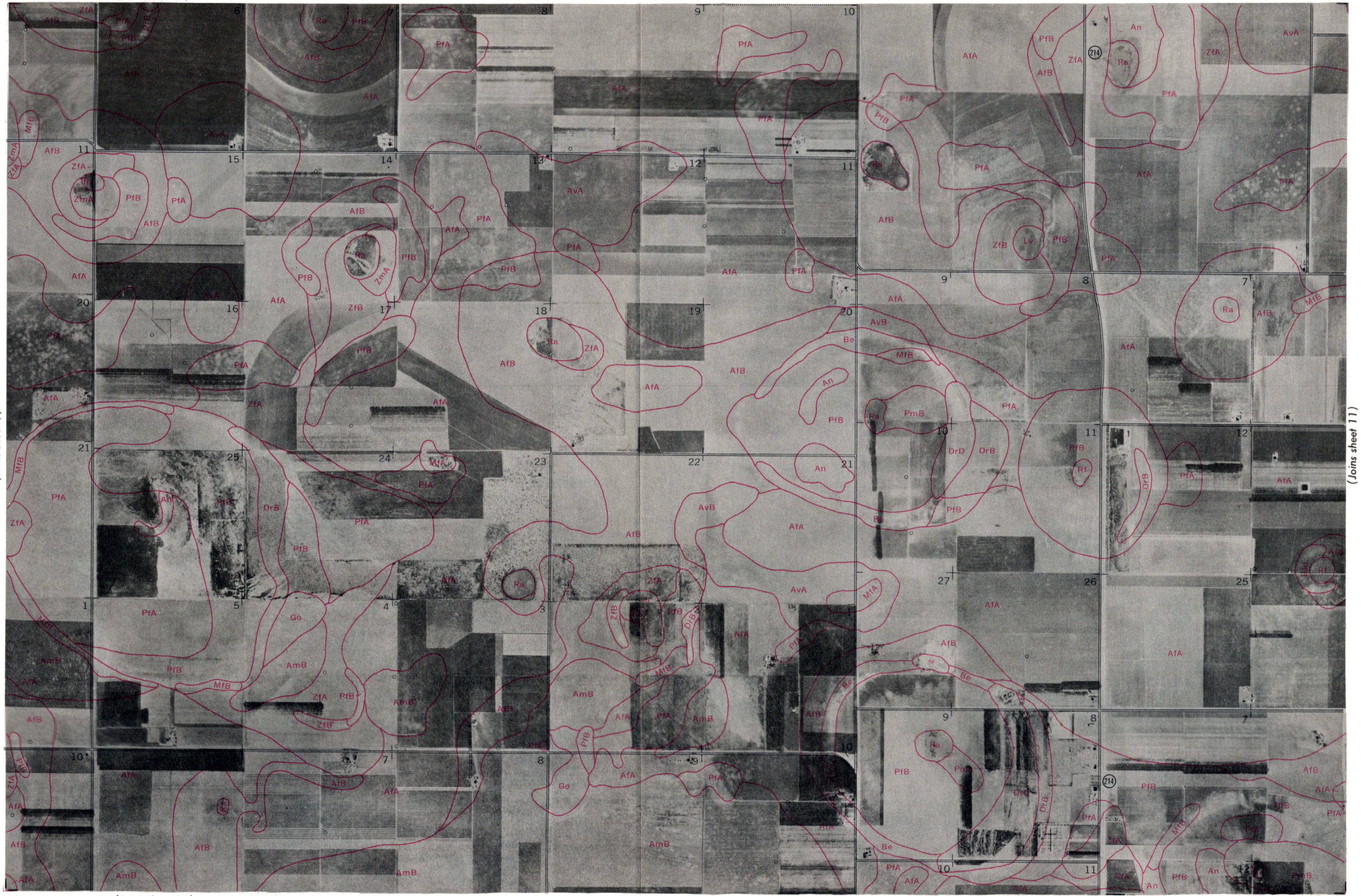

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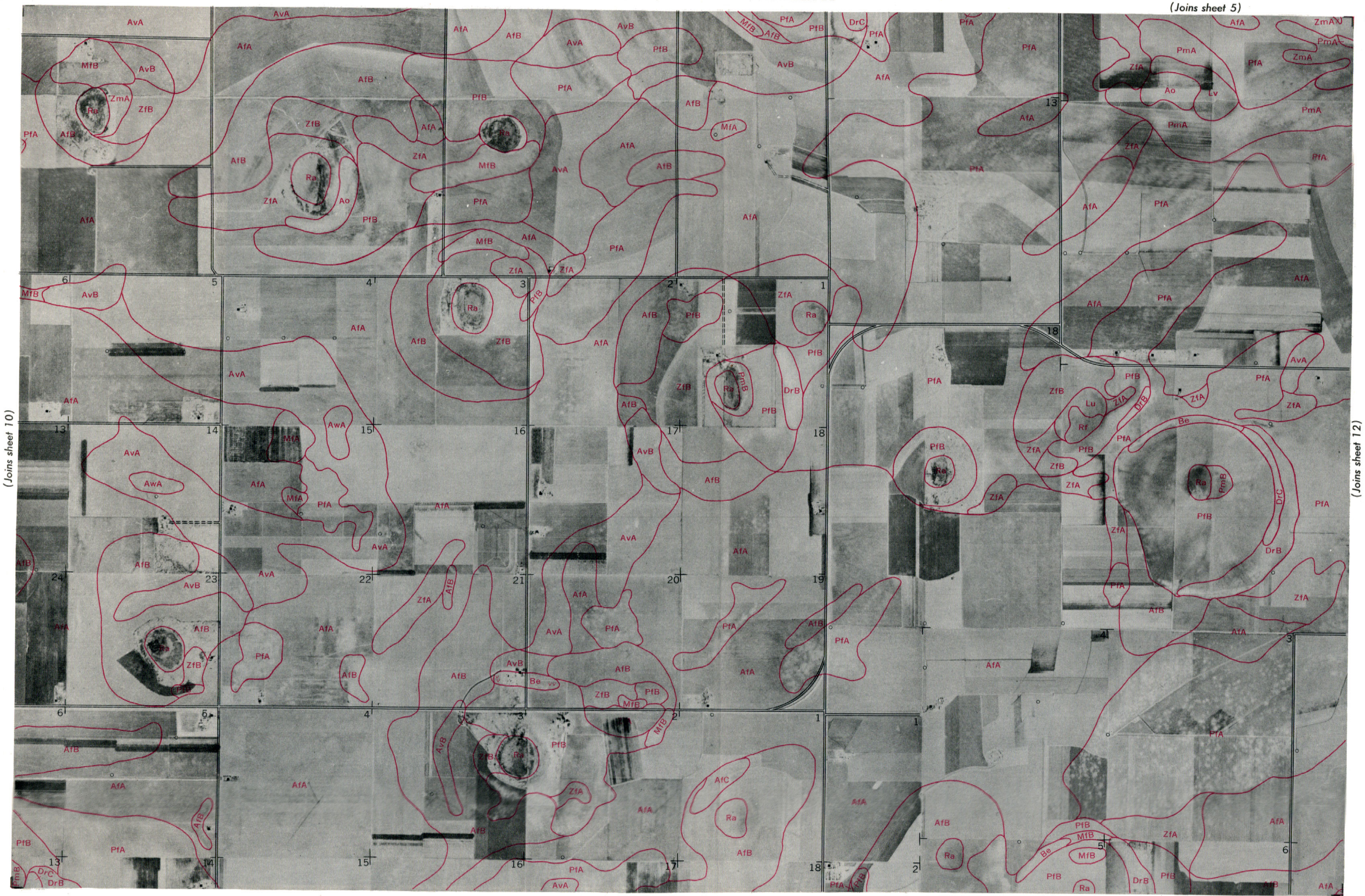

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COCHRAN COUNTY, TEXAS—SHEET NUMBER 12

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COCHRAN COUNTY, TEXAS—SHEET NUMBER 13

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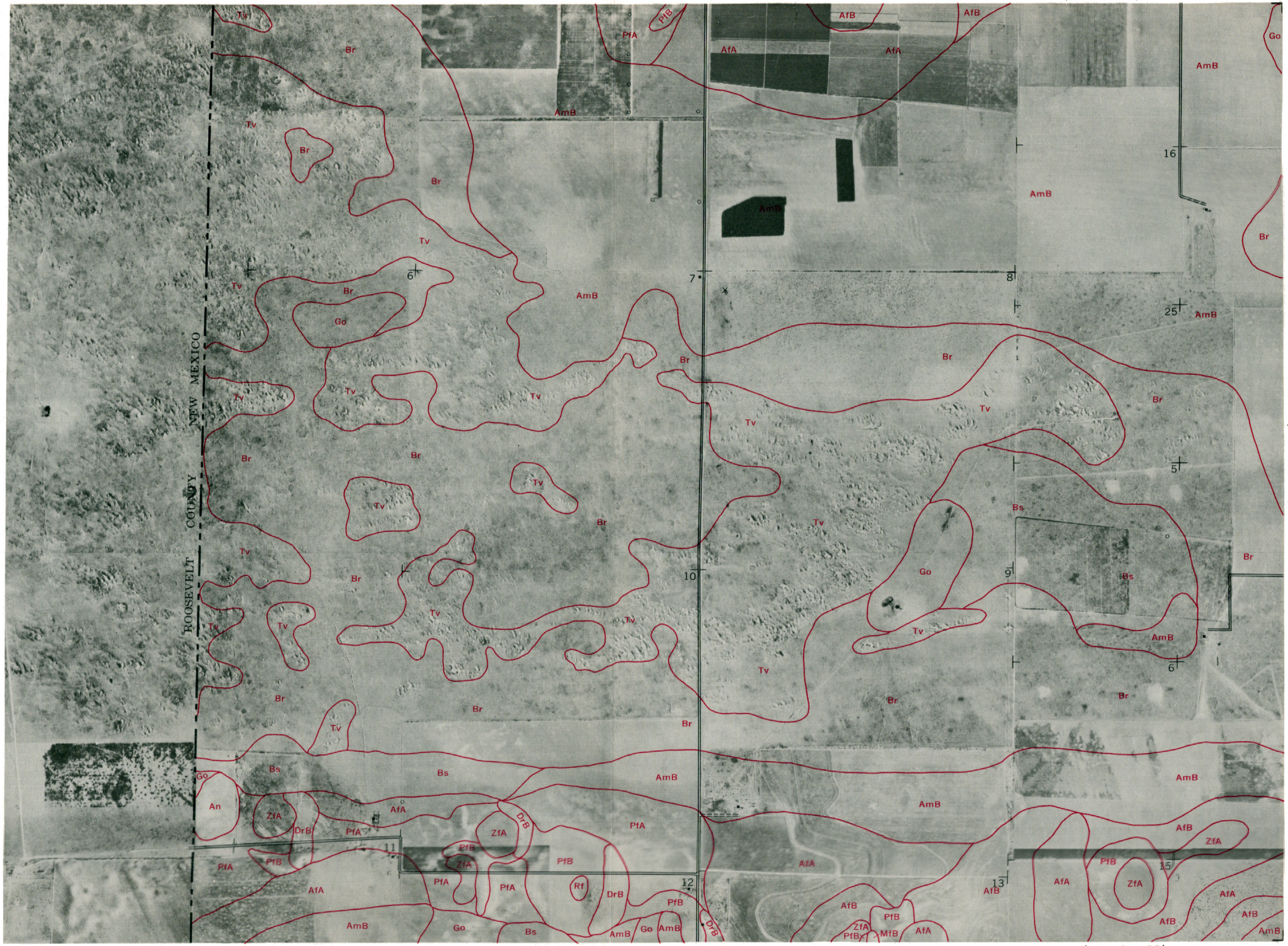

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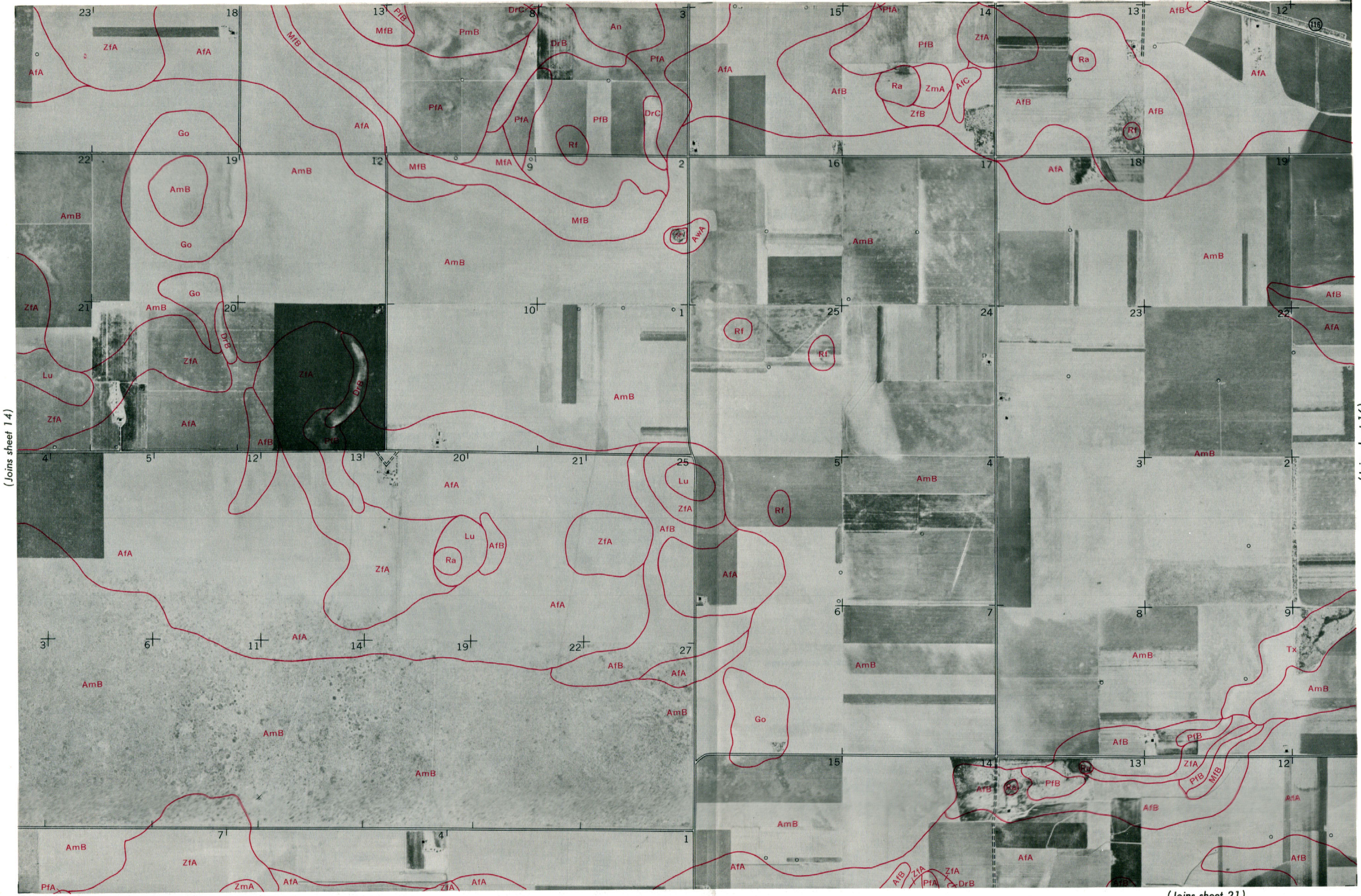
COCHRAN COUNTY, TEXAS—SHEET NUMBER 14

COCHRAN COUNTY, TEXAS—SHEET NUMBER 15

15



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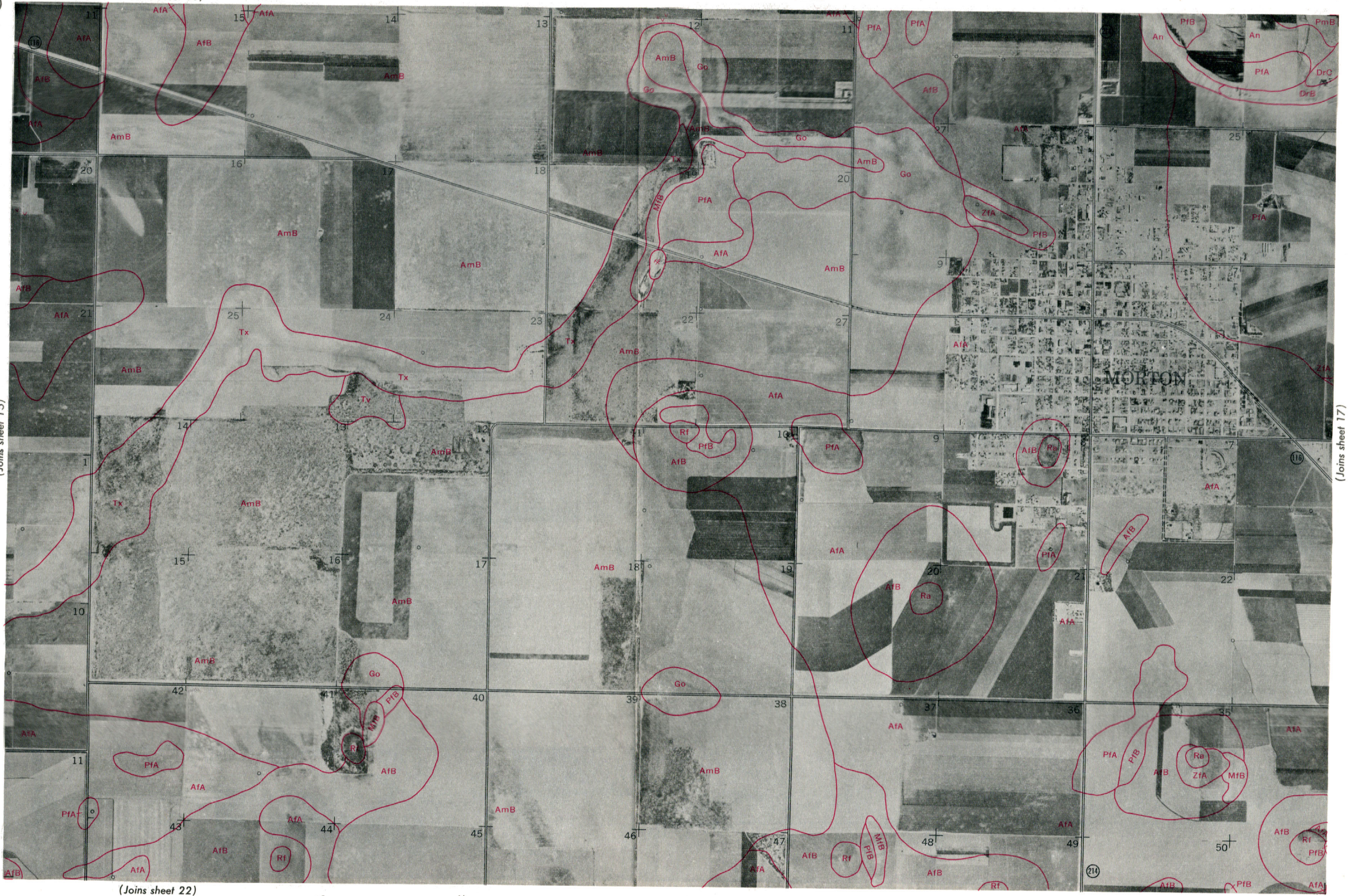

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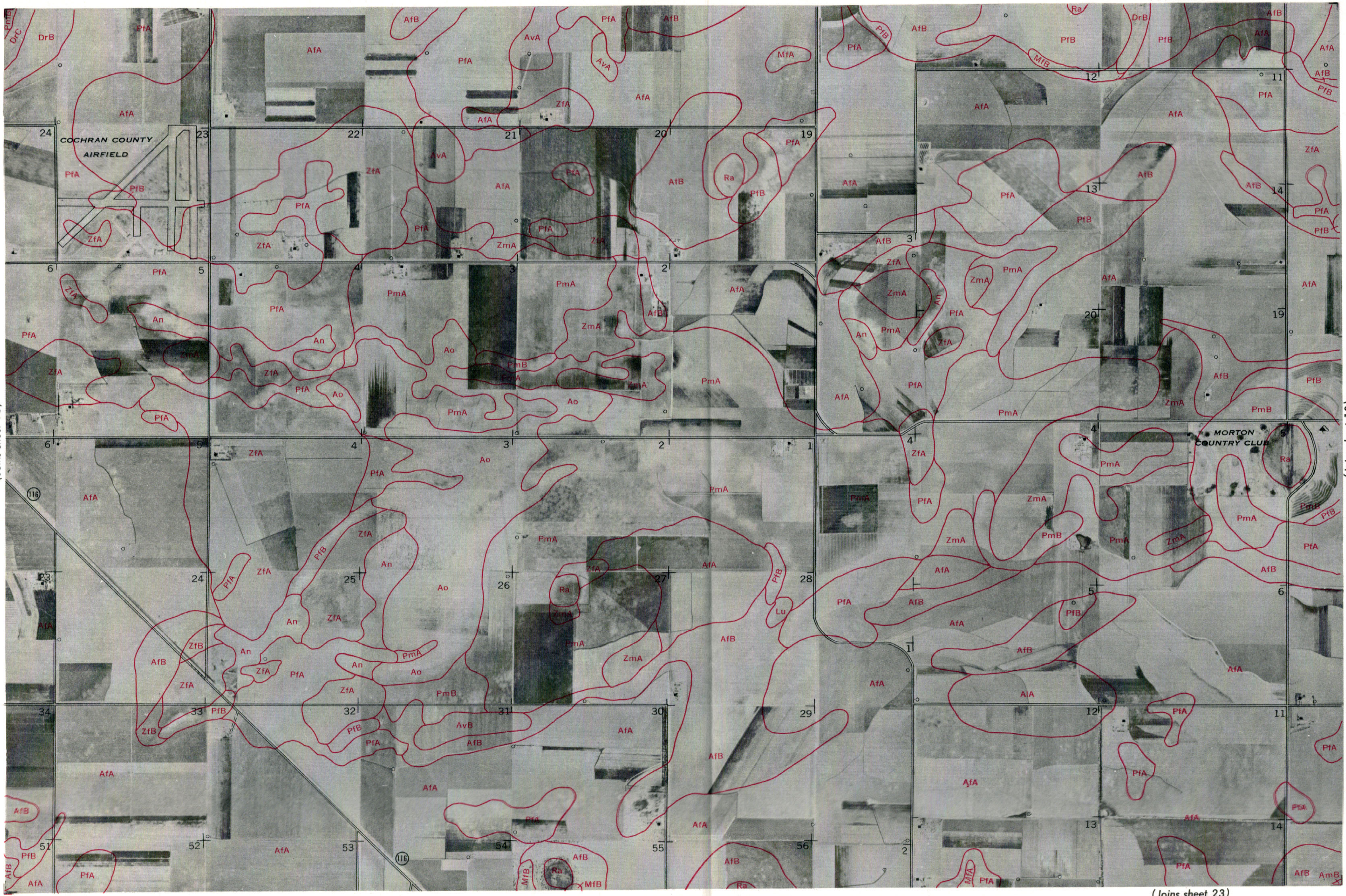

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(18)

COCHRAN COUNTY, TEXAS—SHEET NUMBER 18

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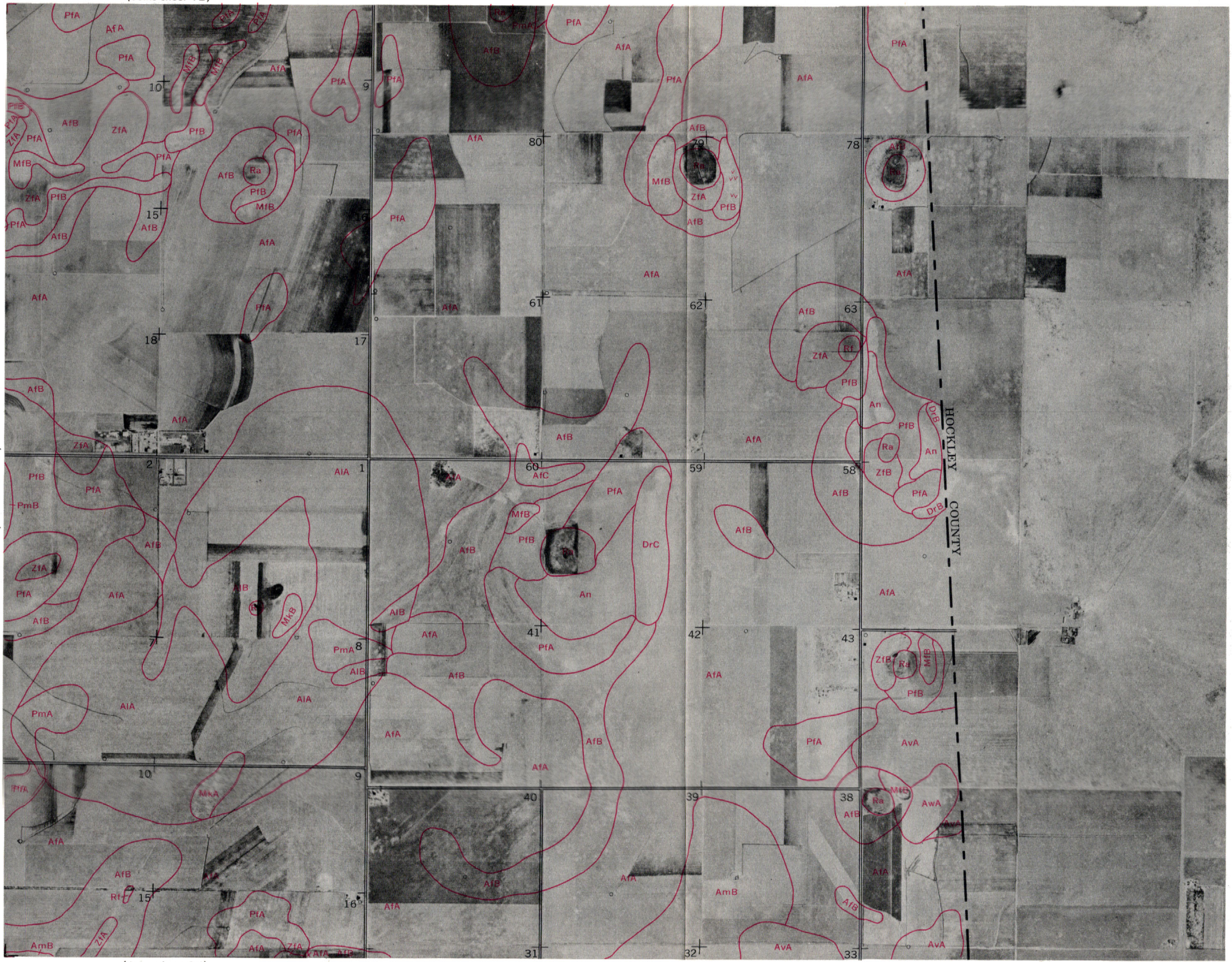

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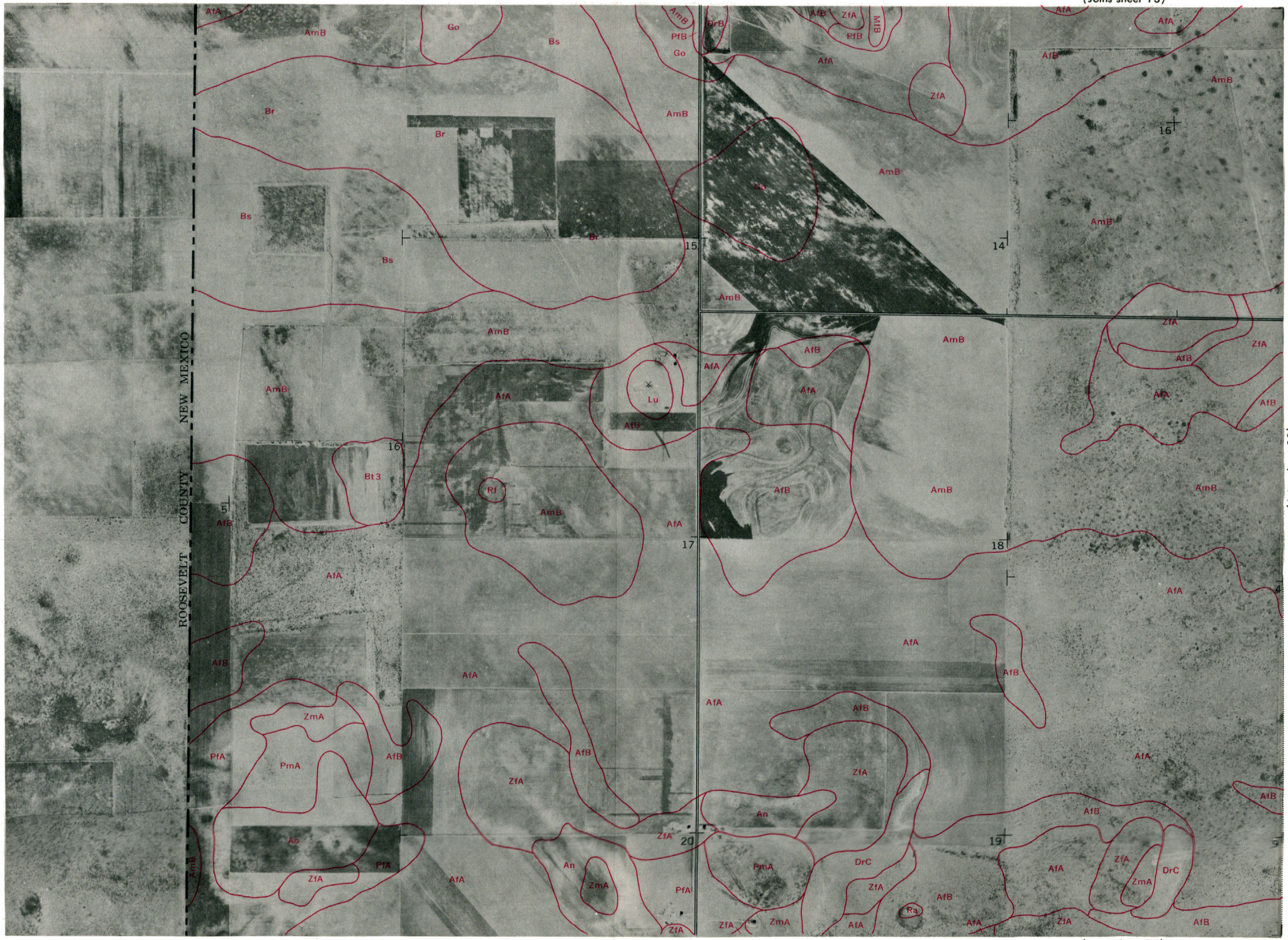

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COCHRAN COUNTY, TEXAS—SHEET NUMBER 20

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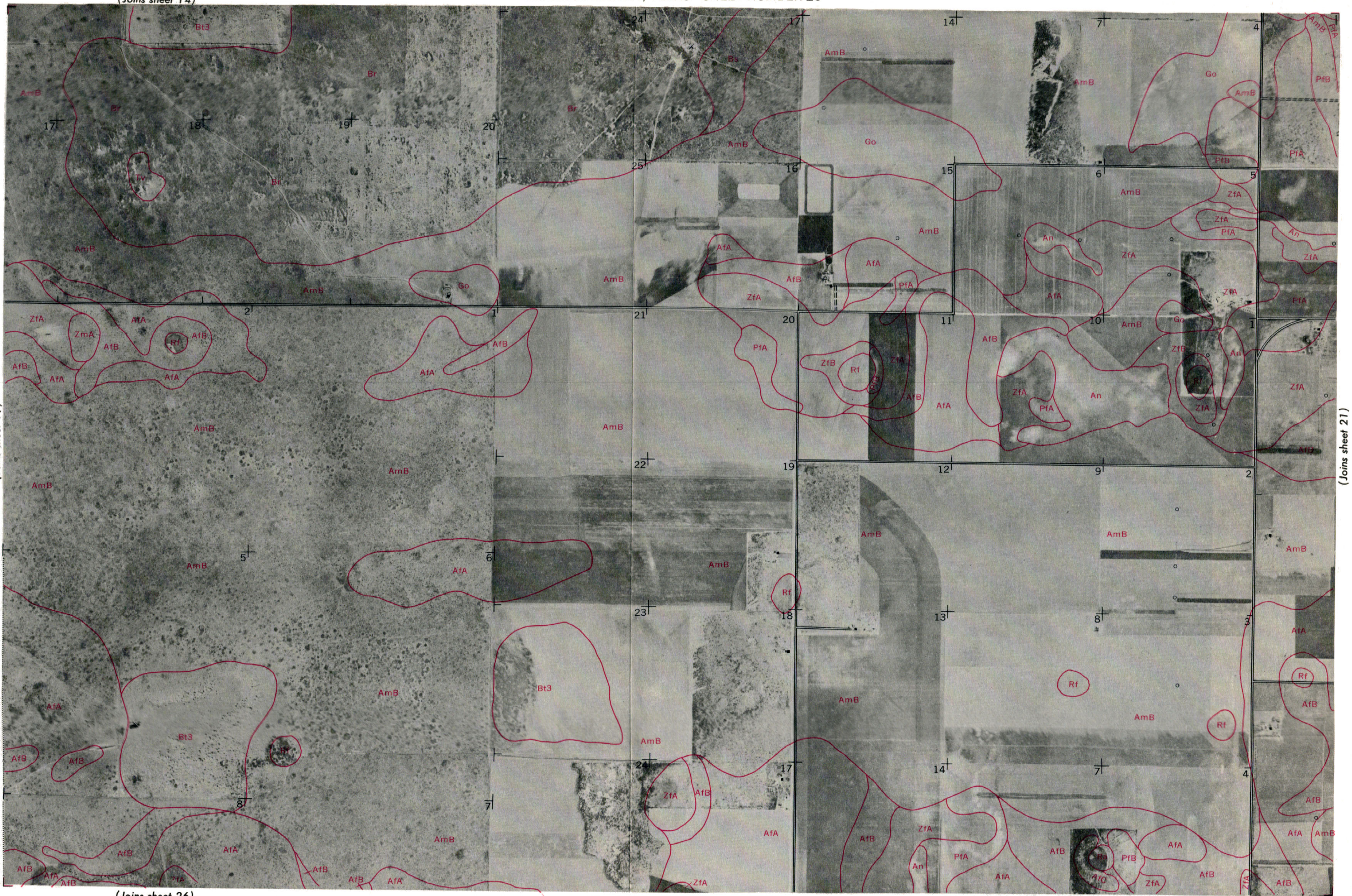

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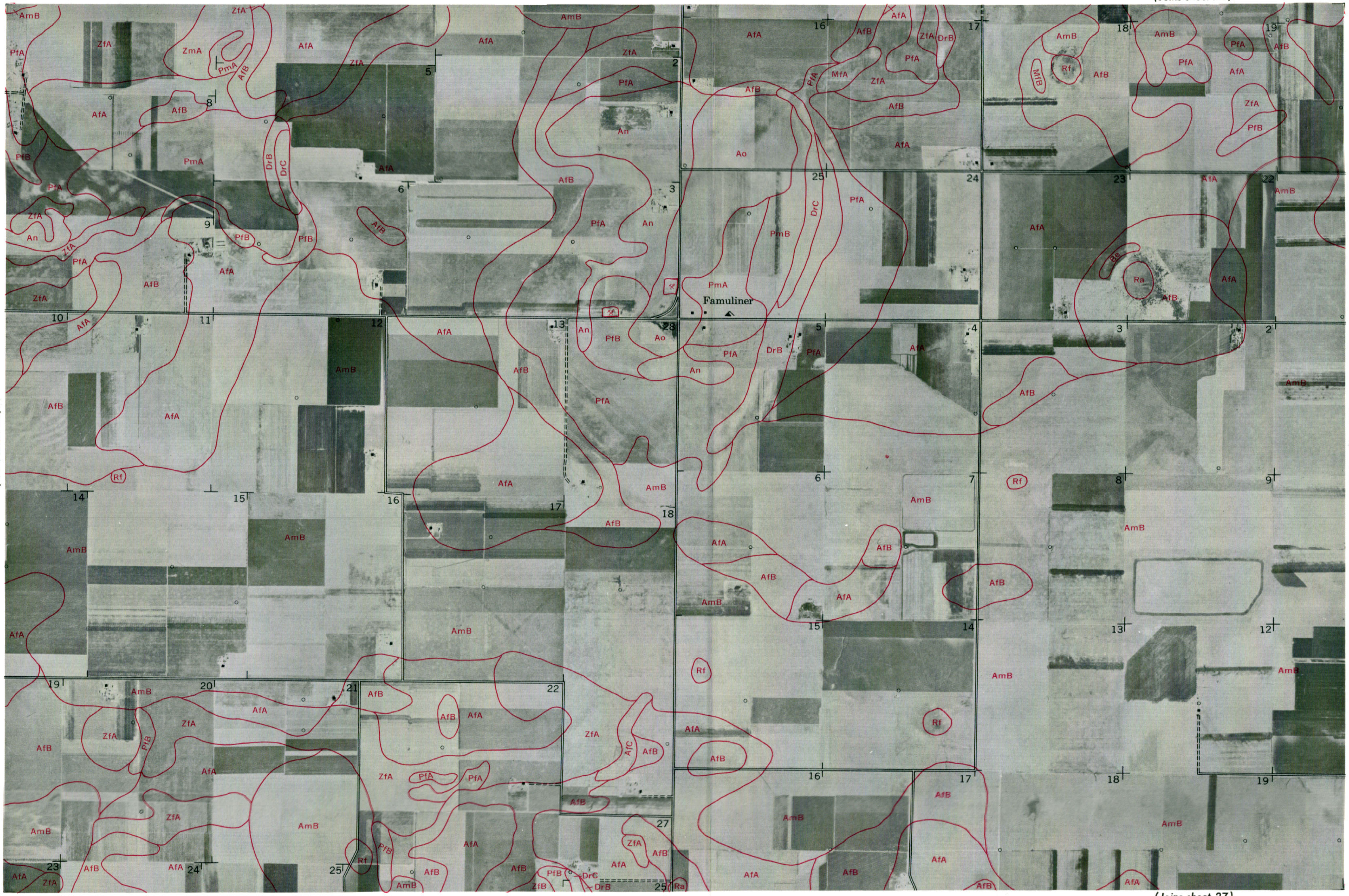

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Land division corners and numbers shown on this map are indefinite

COCHRAN COUNTY, TEXAS—SHEET NUMBER 22

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

(Joins sheet 17)

(Joins sheet 29)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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Land division corners and numbers shown on this map are indefinite

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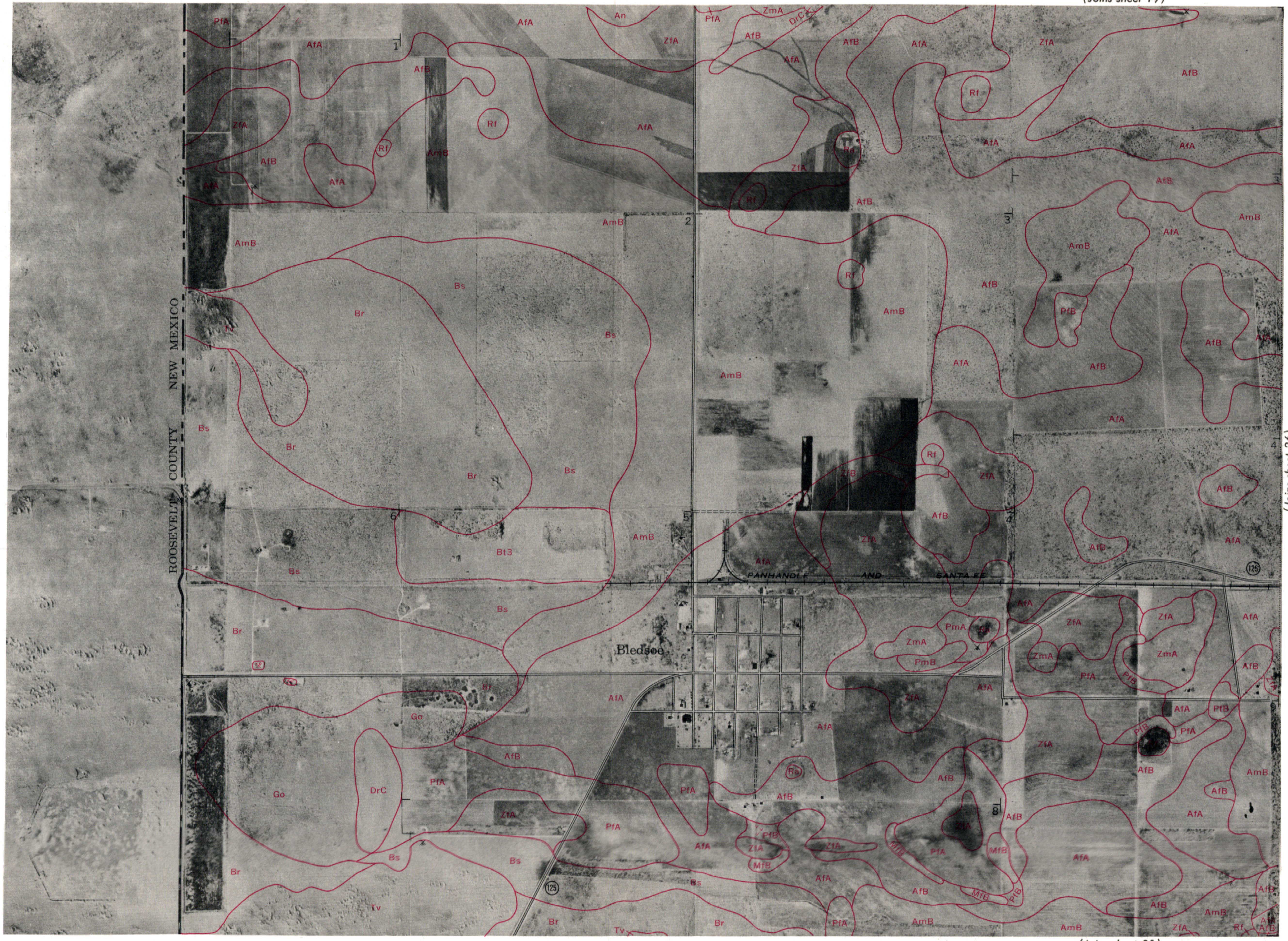

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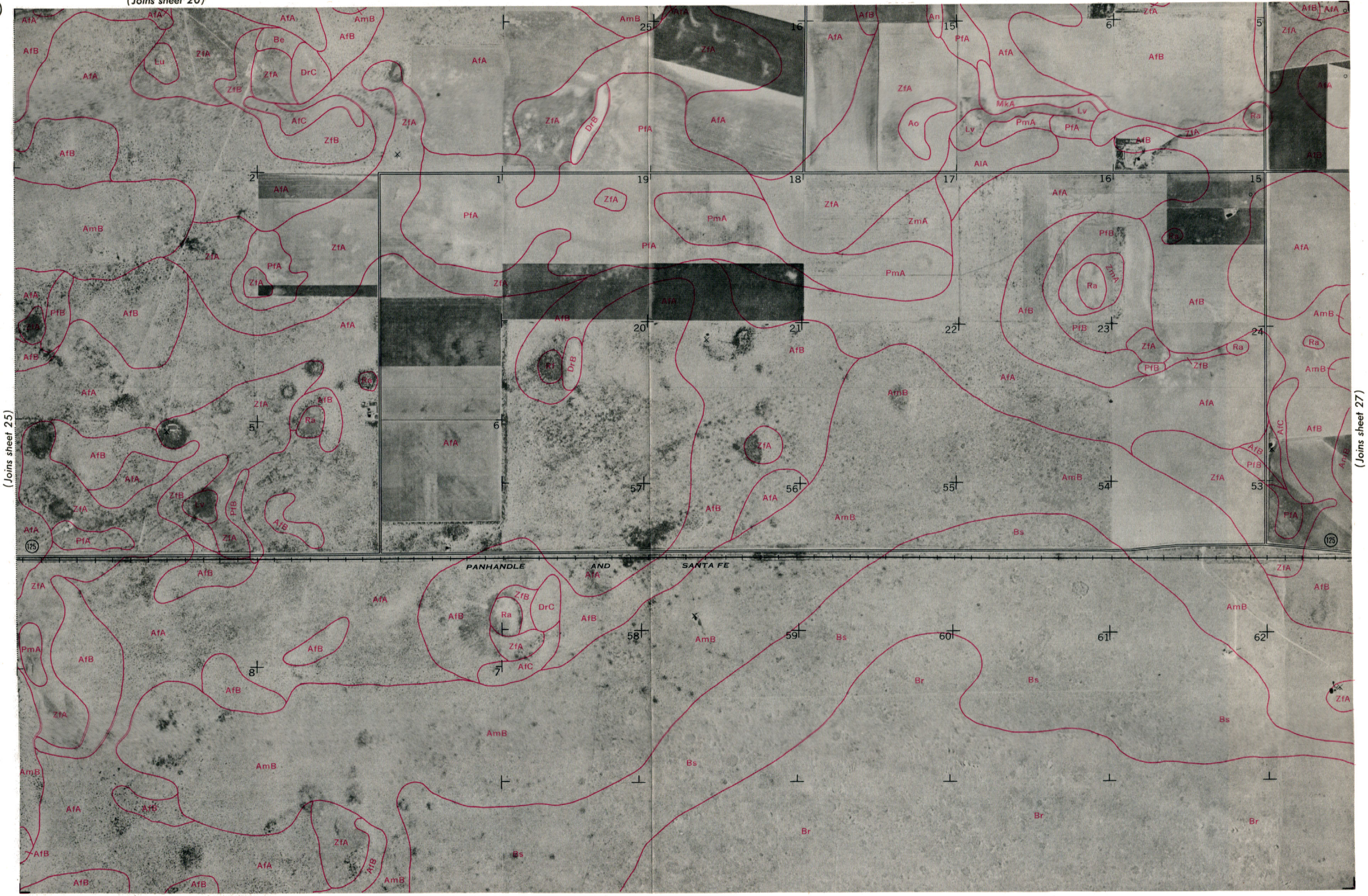
Land division corners and numbers shown on this map are indefinite

COCHRAN COUNTY, TEXAS—SHEET NUMBER 26

(Joins sheet 20)

N

(Joins sheet 25)



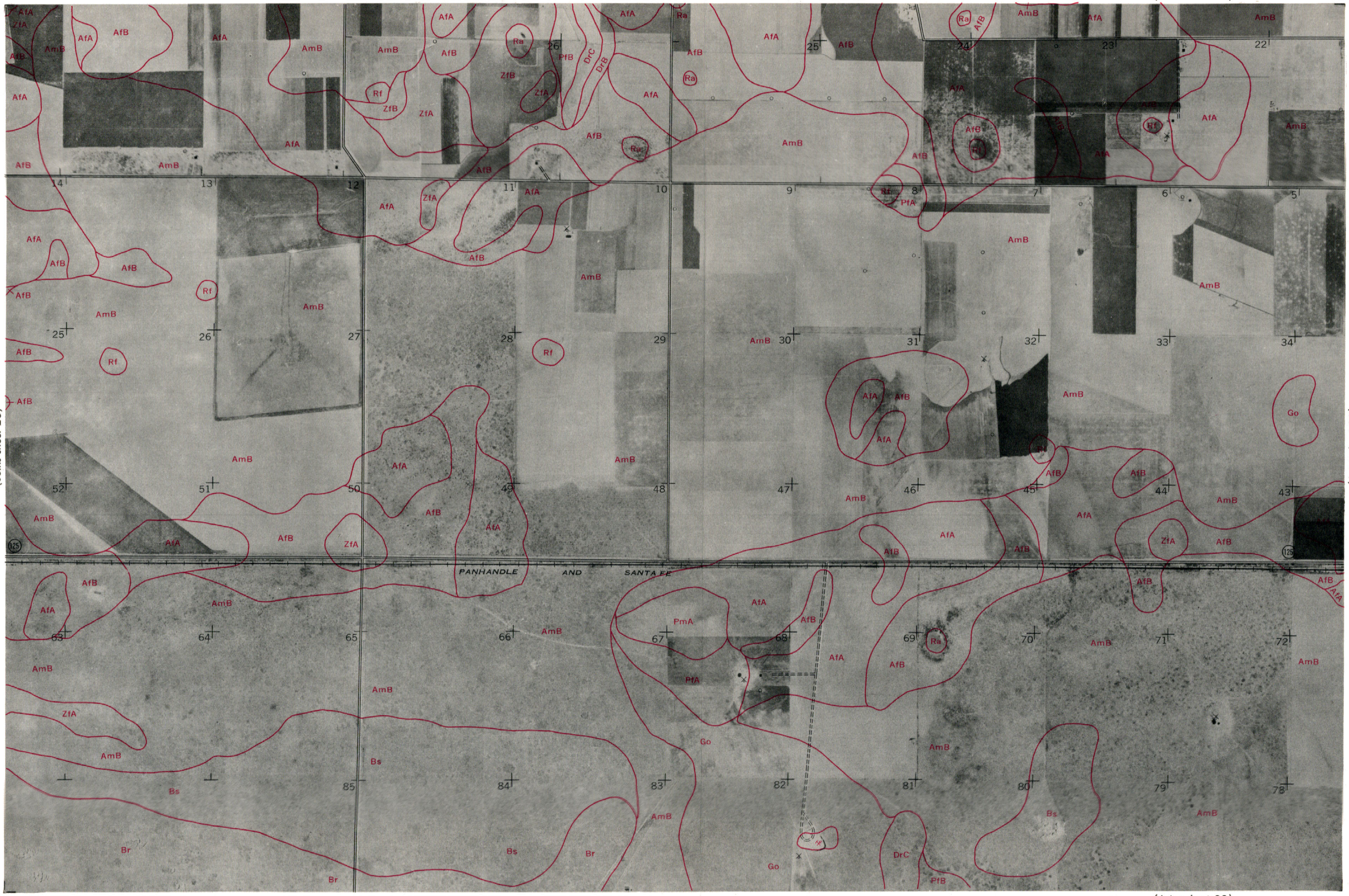
(Joins sheet 27)

(Joins sheet 32)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

(Joins sheet 21)

(Joins sheet 26)



(Joins sheet 28)

(Joins sheet 33)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

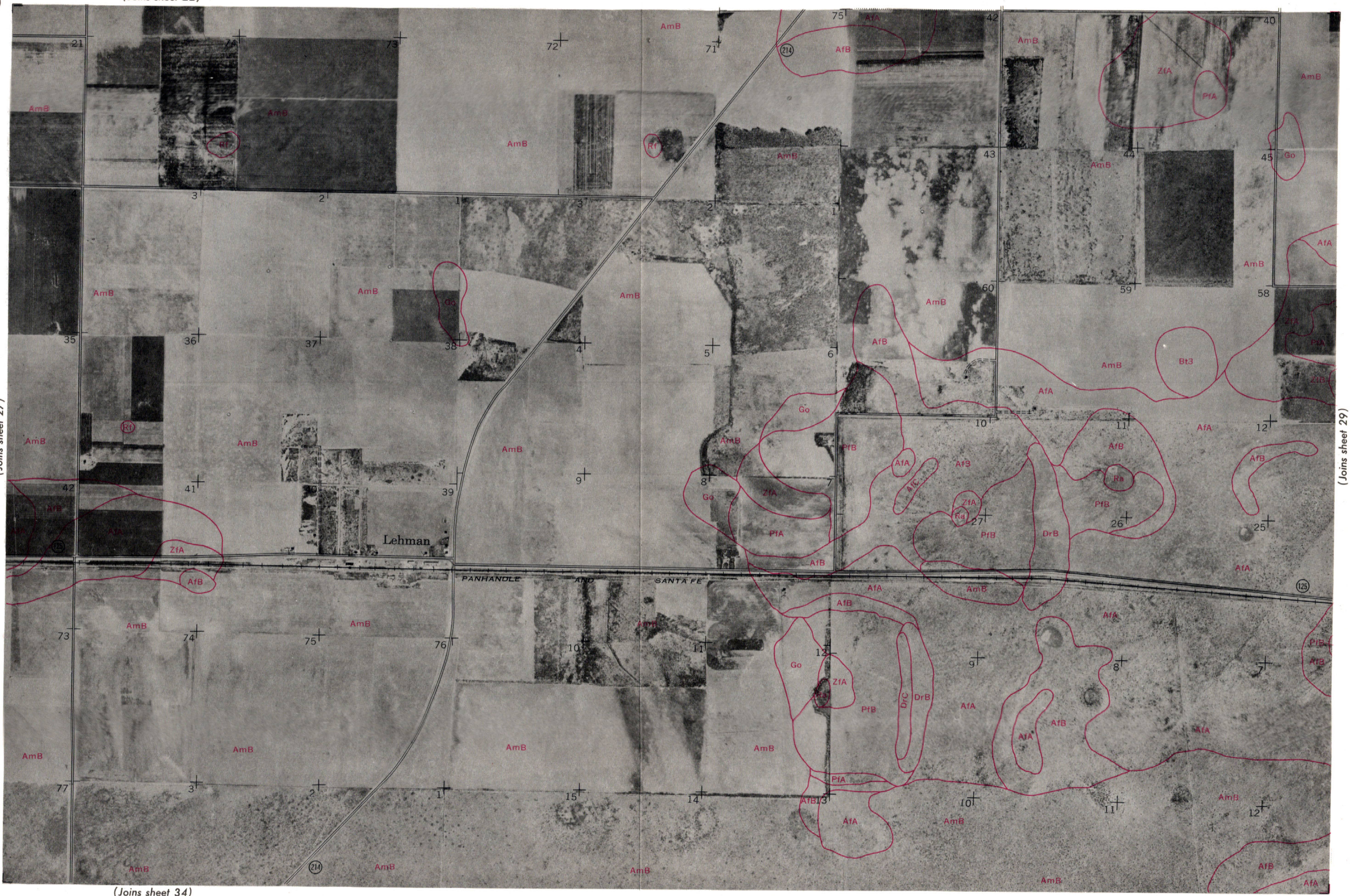
This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite

COCHRAN COUNTY, TEXAS—SHEET NUMBER 28

(Joins sheet 22)

(Joins sheet 27)



(Joins sheet 29)

(Joins sheet 34)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

(Joins sheet 23)

(Joins sheet 28)

(Joins sheet 30)

(Joins sheet 35)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite

(30)

COCHRAN COUNTY, TEXAS—SHEET NUMBER 30

(Joins sheet 24)

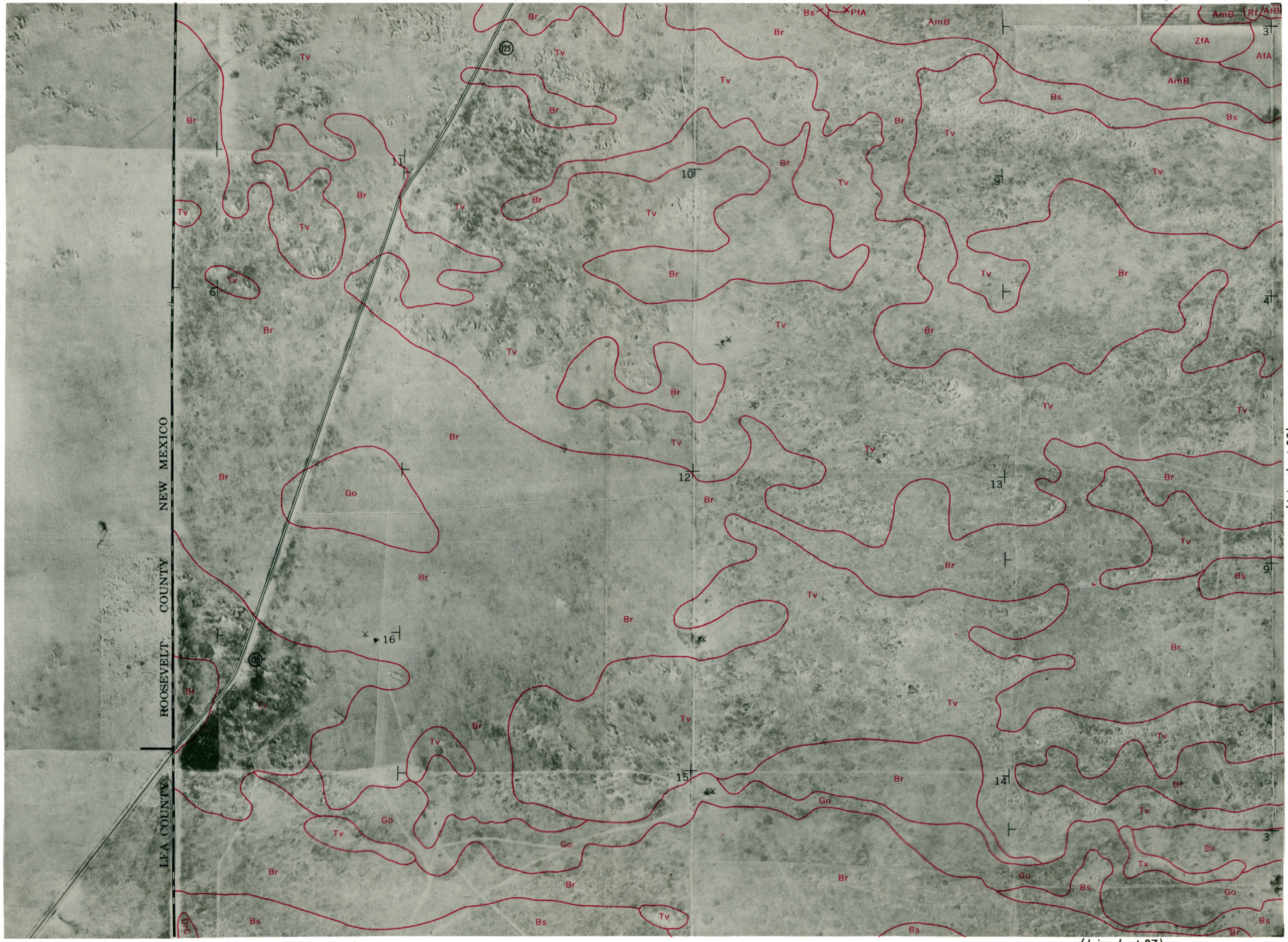
(Joins sheet 29)

(Joins sheet 36)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

(Joins sheet 25)

31



(Joins sheet 37)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite

COCHRAN COUNTY, TEXAS—SHEET NUMBER 32

(Joins sheet 26)

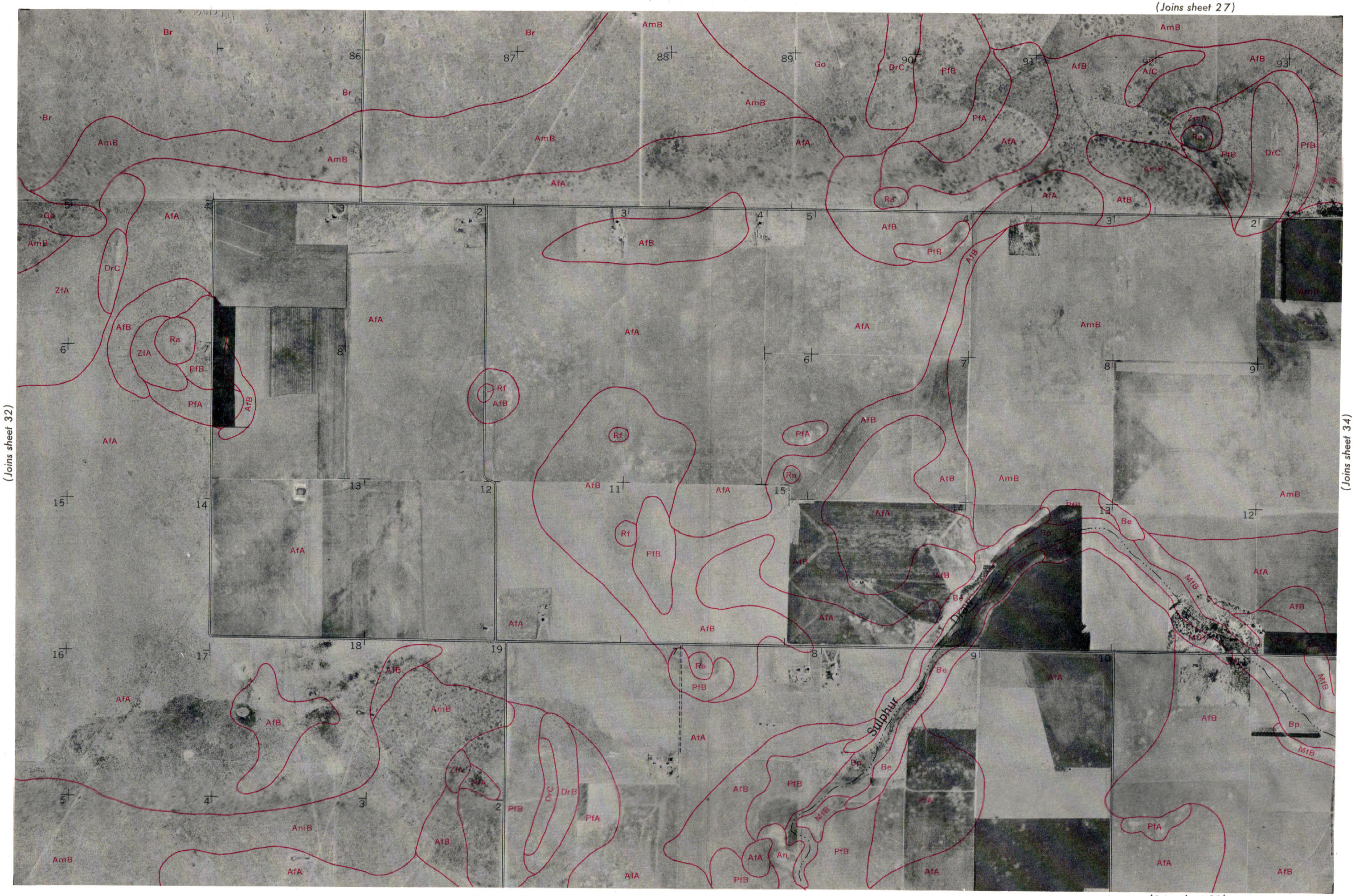
N

(Joins sheet 31)

(Joins sheet 33)

(Joins sheet 38)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite

COCHRAN COUNTY, TEXAS—SHEET NUMBER 34

(Joins sheet 28)

(Joins sheet 33)

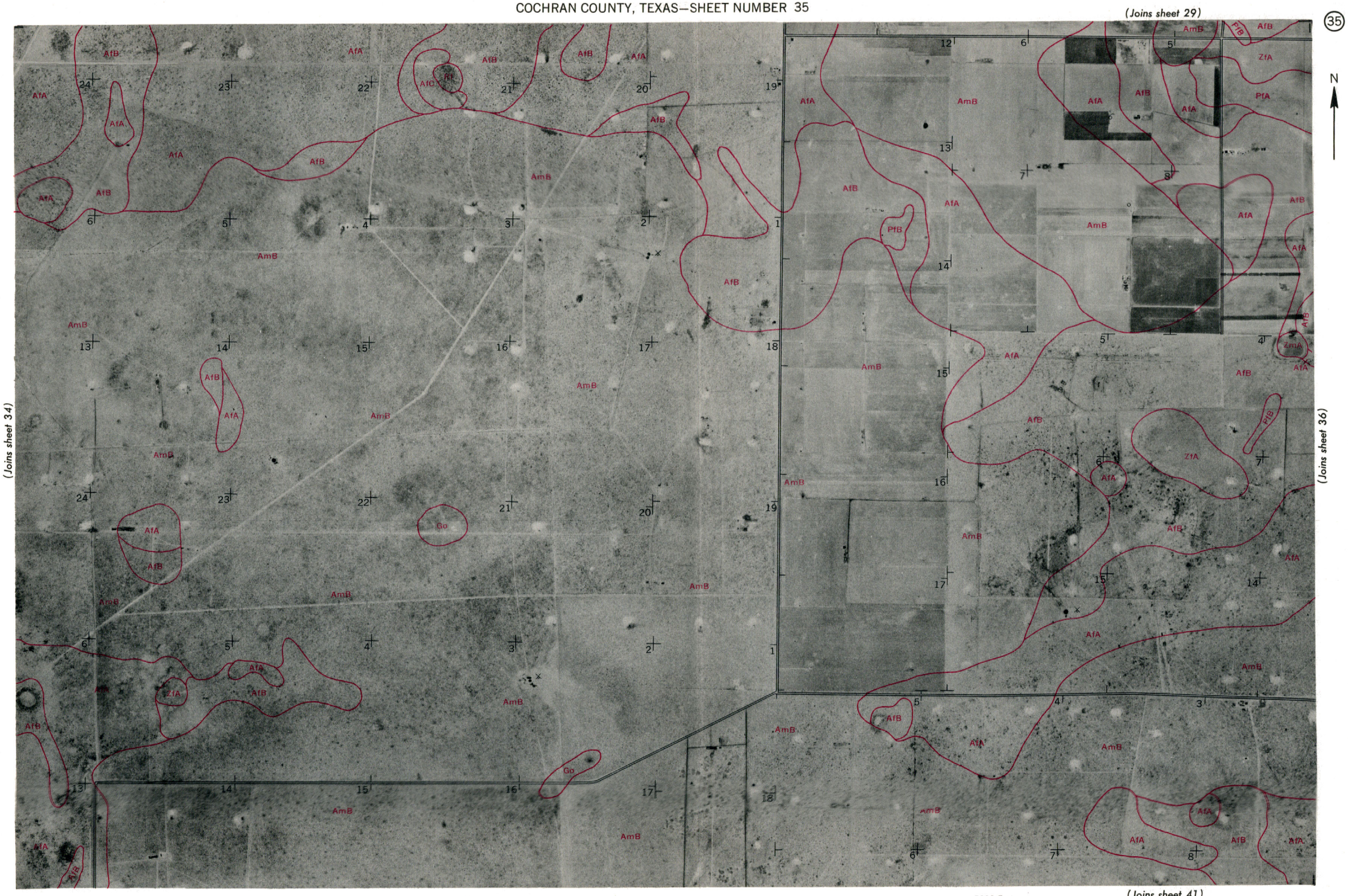
(Joins sheet 35)

(Joins sheet 40)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite

COCHRAN COUNTY, TEXAS—SHEET NUMBER 36

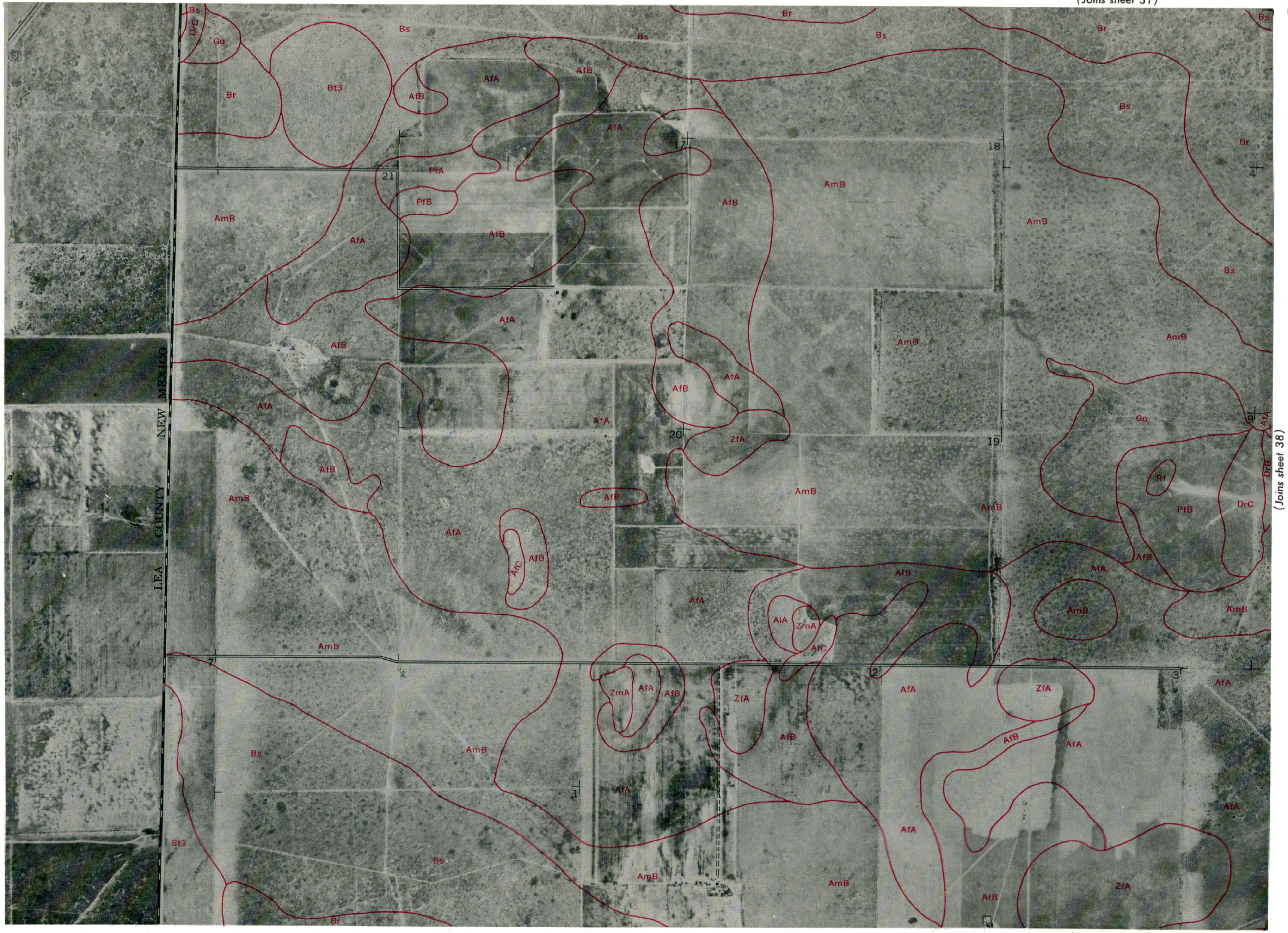
(Joins sheet 30)

(Joins sheet 42)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

COCHRAN COUNTY, TEXAS—SHEET NUMBER 37

(Joins sheet 31)



(Joins sheet 43)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

N

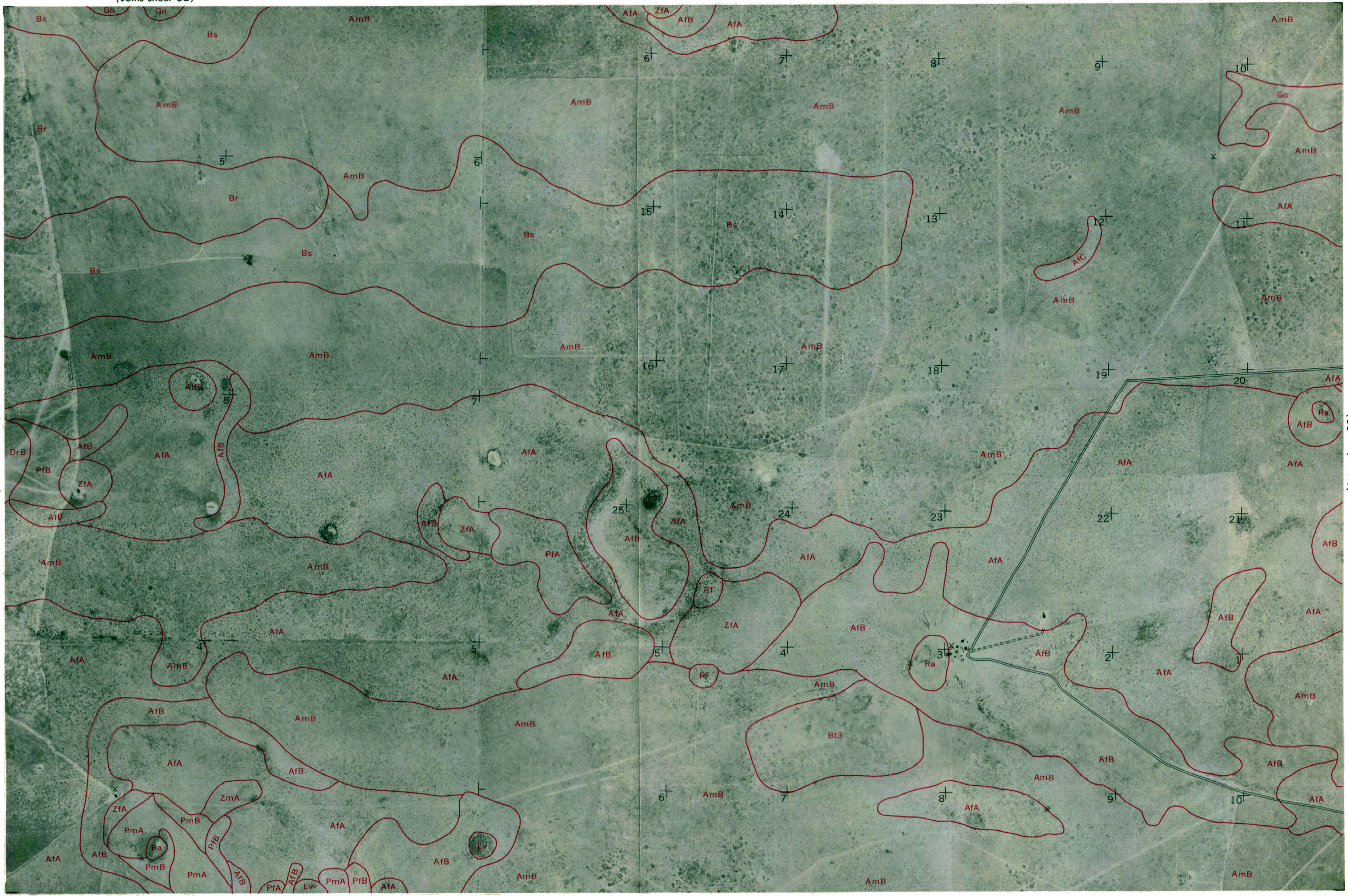
This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite

38

COCHRAN COUNTY, TEXAS—SHEET NUMBER 38

(Joins sheet 32)



(Joins sheet 37)

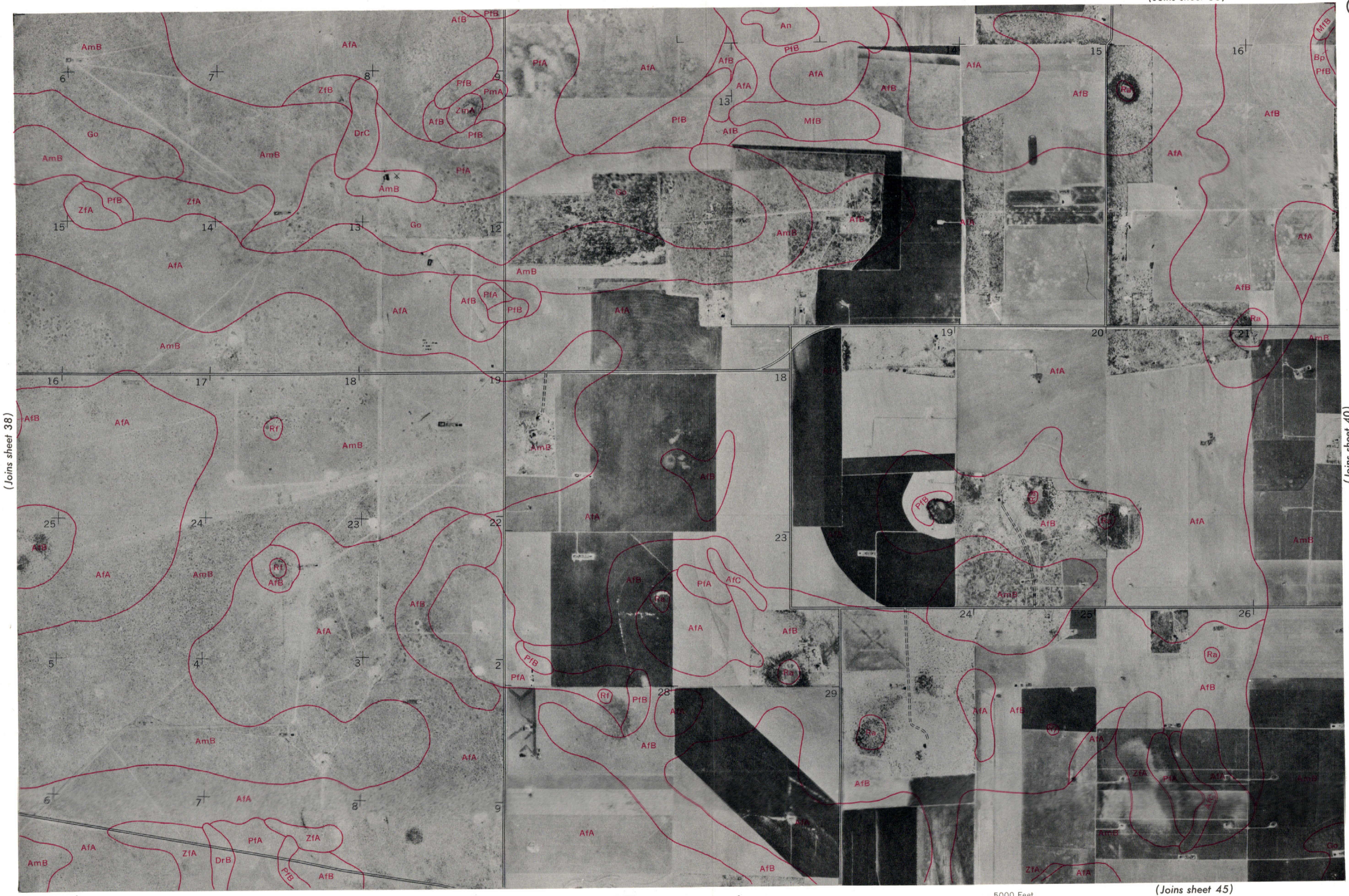
(Joins sheet 39)

(Joins sheet 44)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

(Joins sheet 33)

39



(Joins sheet 38)

(Joins sheet 40)

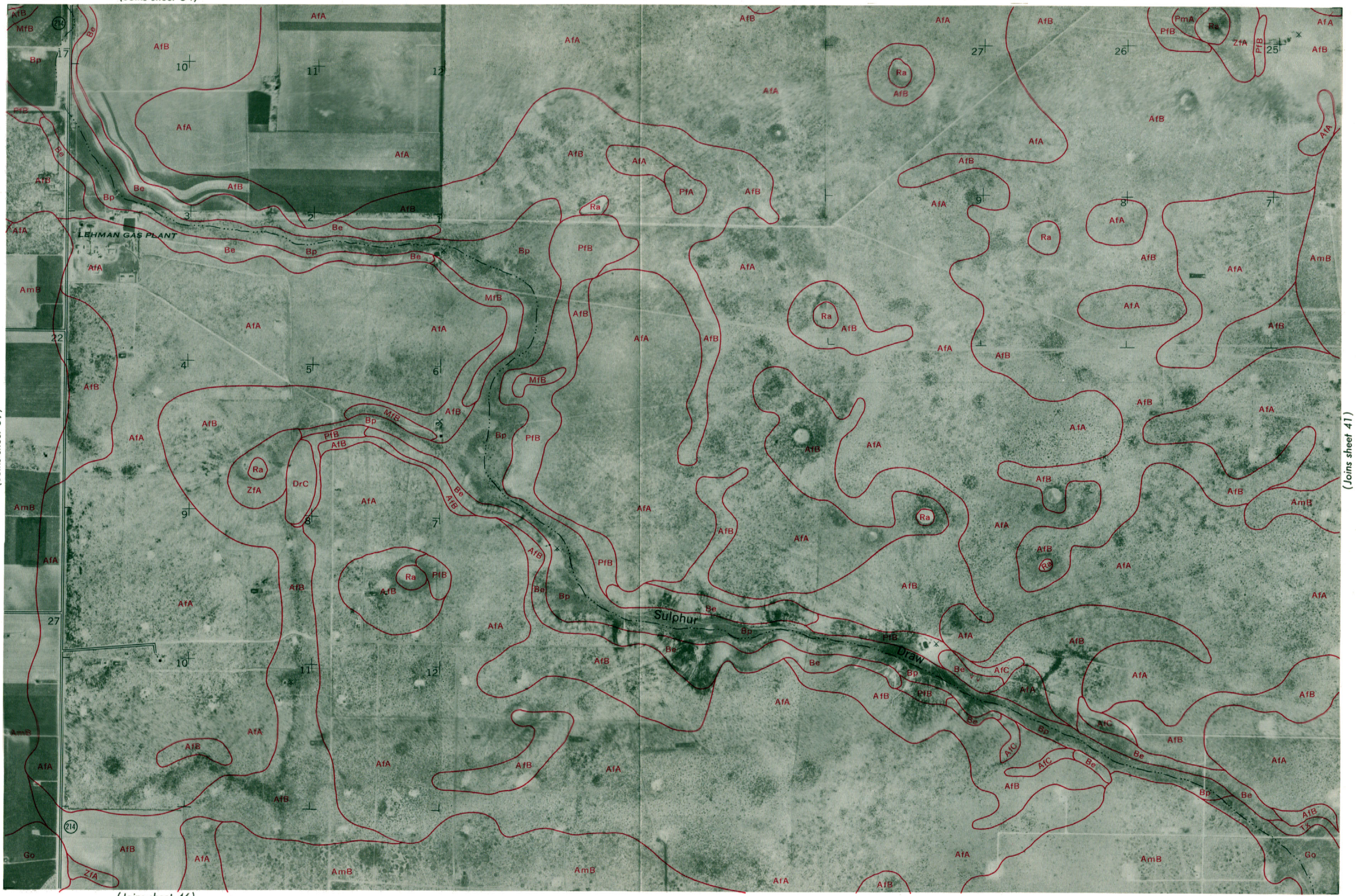
(Joins sheet 45)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite

(Joins sheet 34)



(Joins sheet 46)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

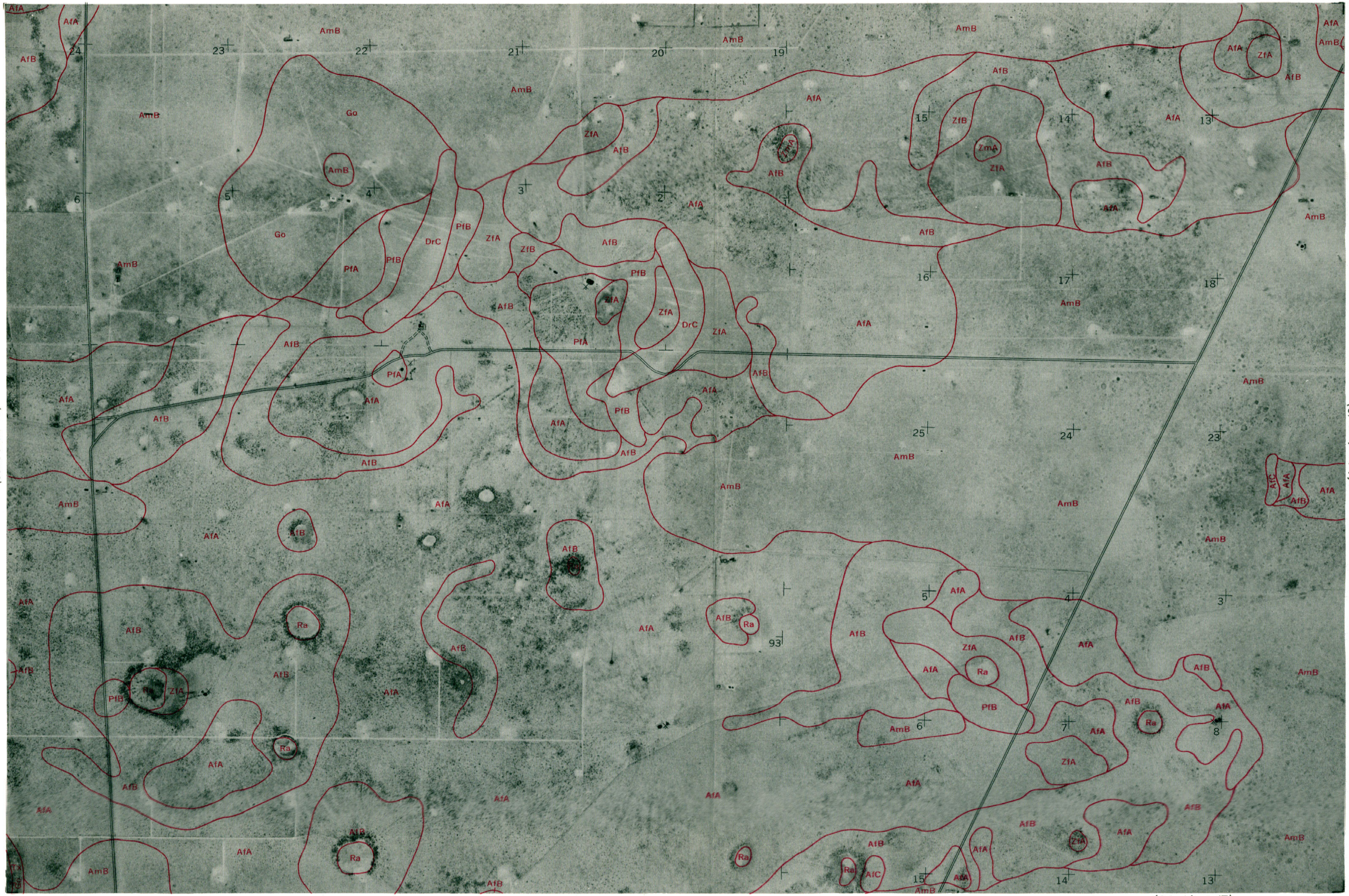
(Joins sheet 35)

41

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite

(Joins sheet 40)



(Joins sheet 42)

(Joins sheet 47)

0 ½ 1 Mile

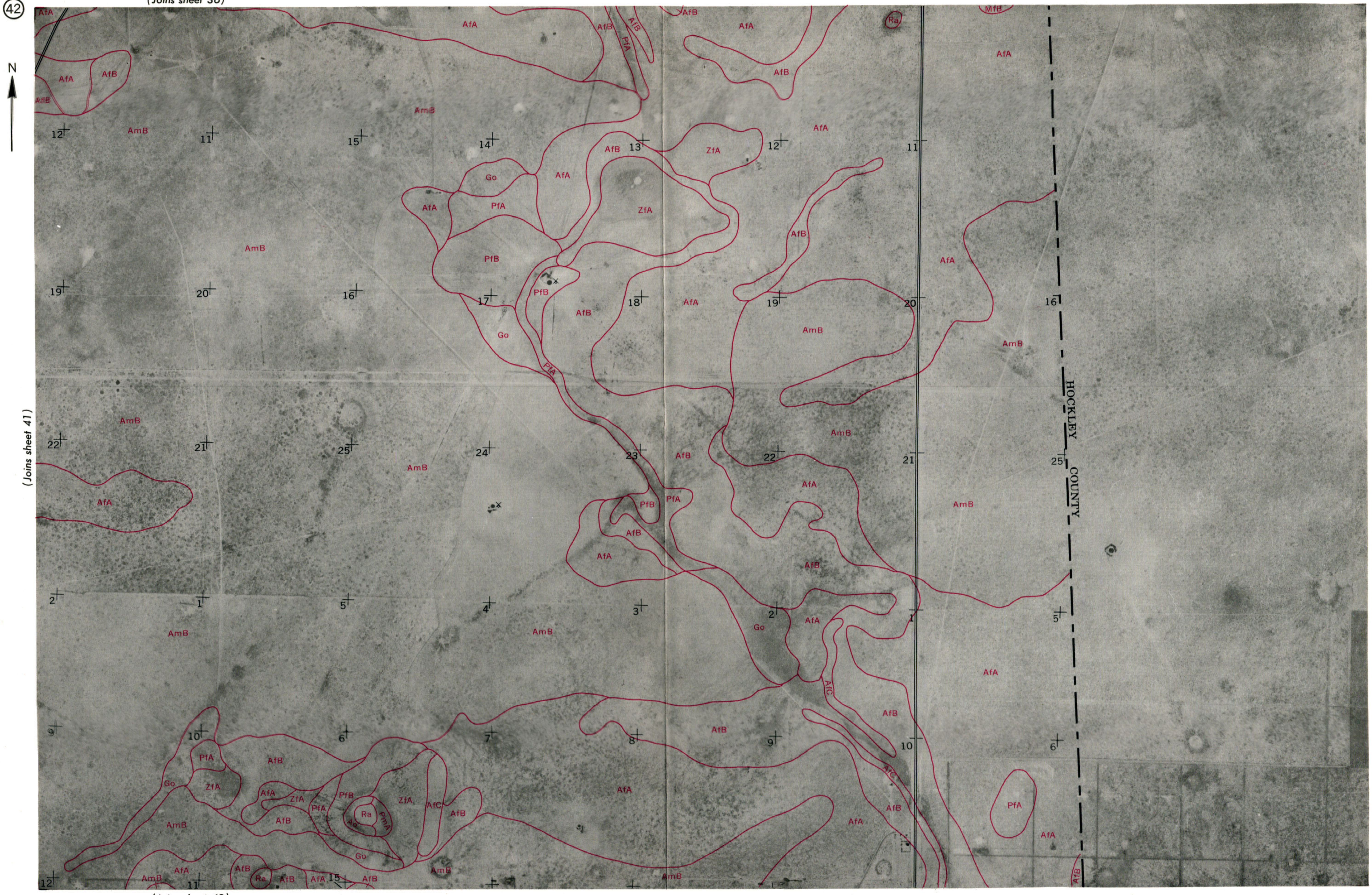
Scale 1:20000

0 5000 Feet

42

COCHRAN COUNTY, TEXAS—SHEET NUMBER 42

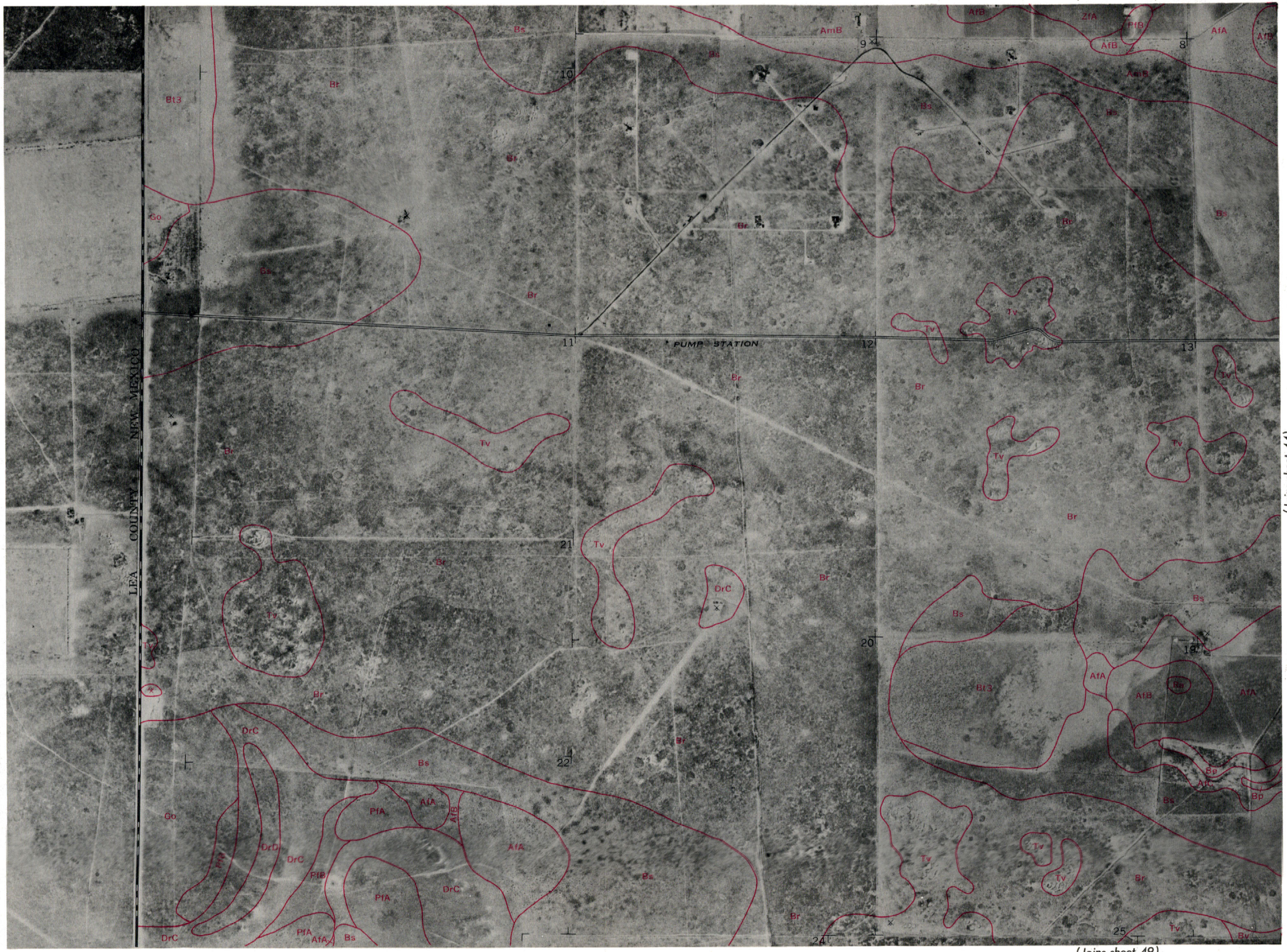
(Joins sheet 36)



(Joins sheet 48)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

(Joins sheet 37)



(Joins sheet 44)

(Joins sheet 49)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

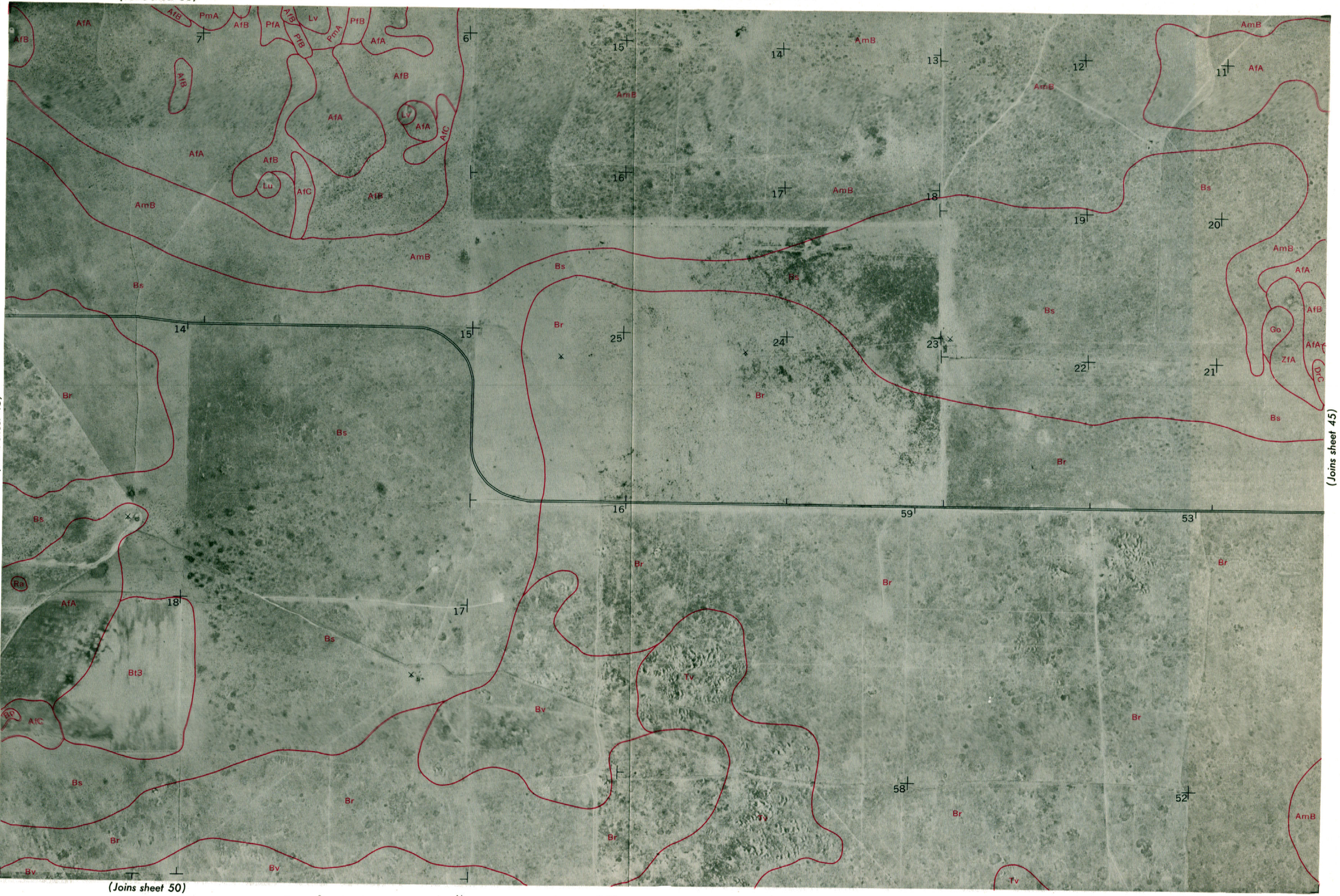
Land division corners and numbers shown on this map are indefinite

44

COCHRAN COUNTY, TEXAS—SHEET NUMBER 44

(Joins sheet 38)

(Joins sheet 43)



(Joins sheet 45)

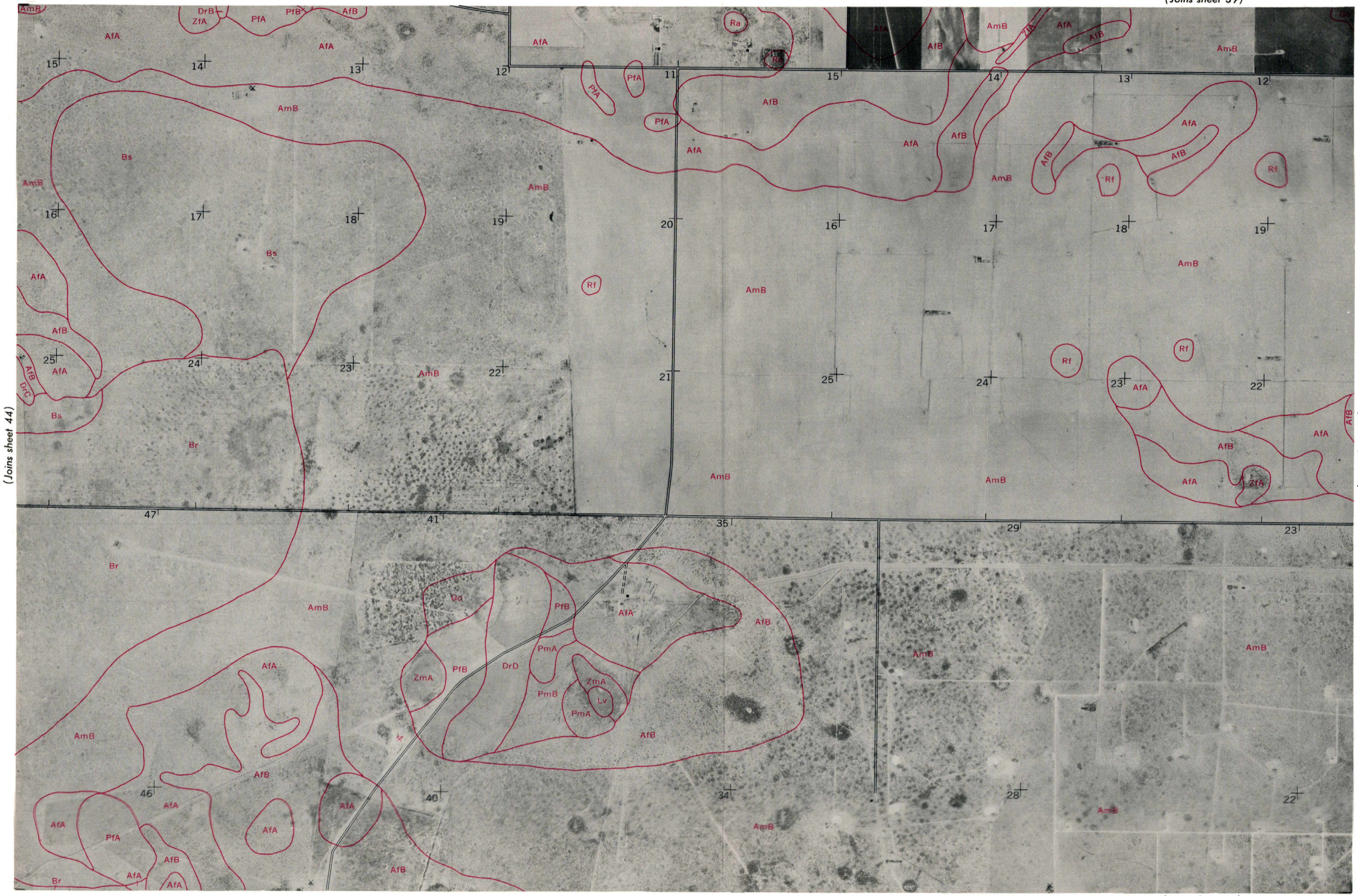
(Joins sheet 50)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

(Joins sheet 39)

45

N



(Joins sheet 44)

(Joins sheet 46)

(Joins sheet 51)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

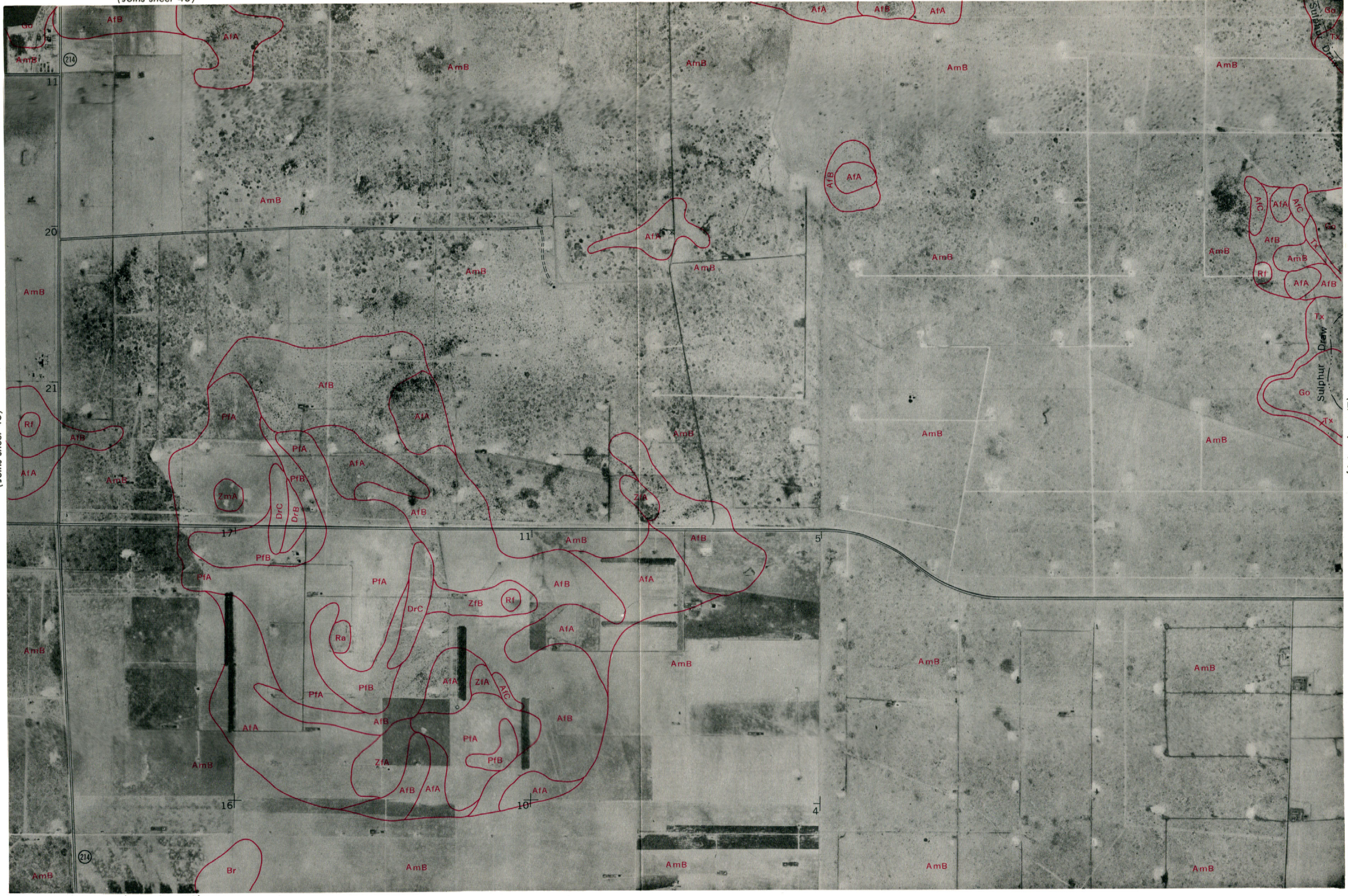
This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite

COCHRAN COUNTY, TEXAS—SHEET NUMBER 46

(Joins sheet 40)

(Joins sheet 45)



(Joins sheet 47)

(Joins sheet 52)

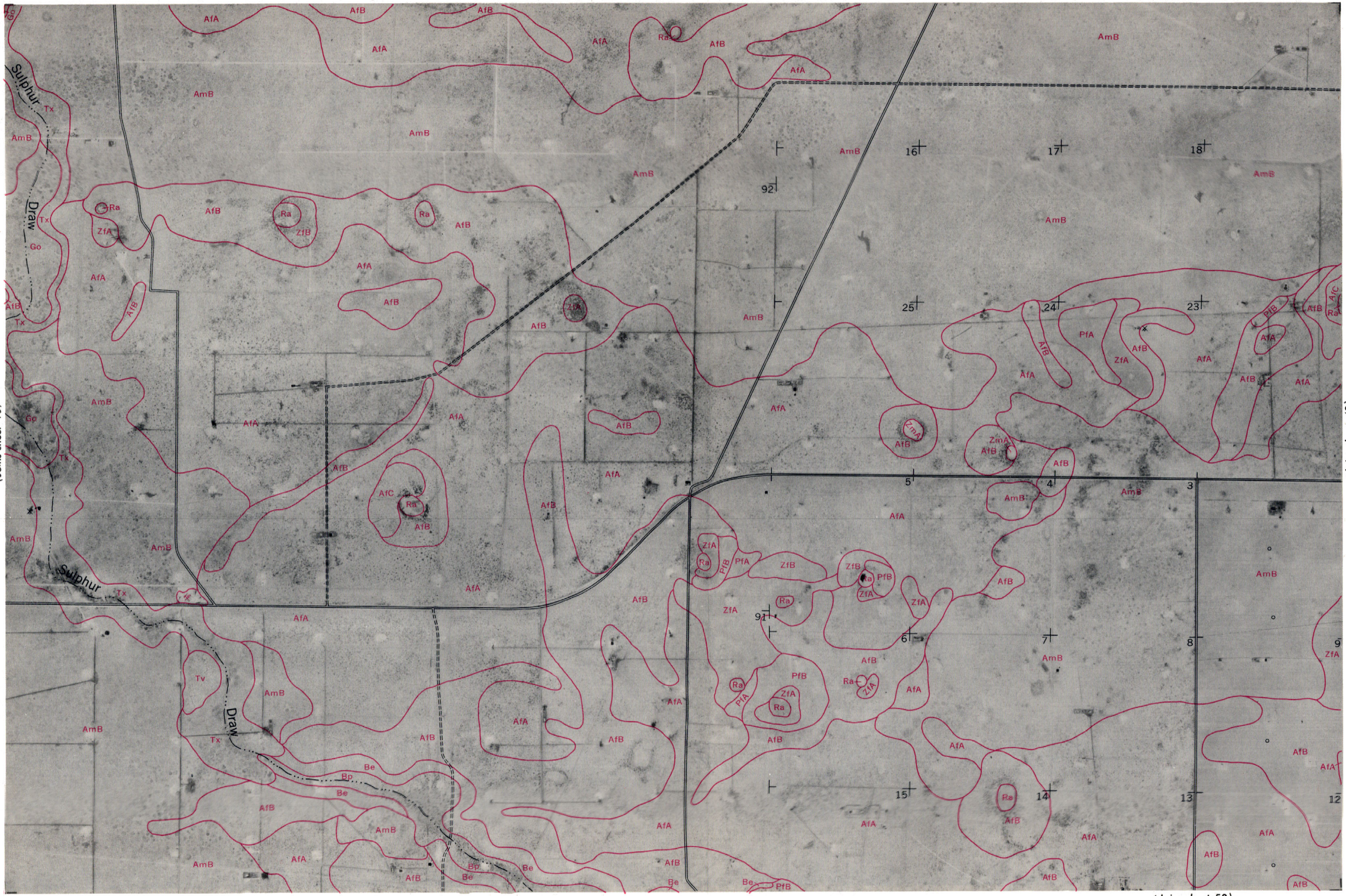
0 ½ 1 Mile Scale 1:20000 0 5000 Feet

COCHRAN COUNTY, TEXAS—SHEET NUMBER 47

(47)

(Joins sheet 41)

(Joins sheet 46)



(Joins sheet 48)

(Joins sheet 53)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture and the Texas Agricultural Experiment Station.

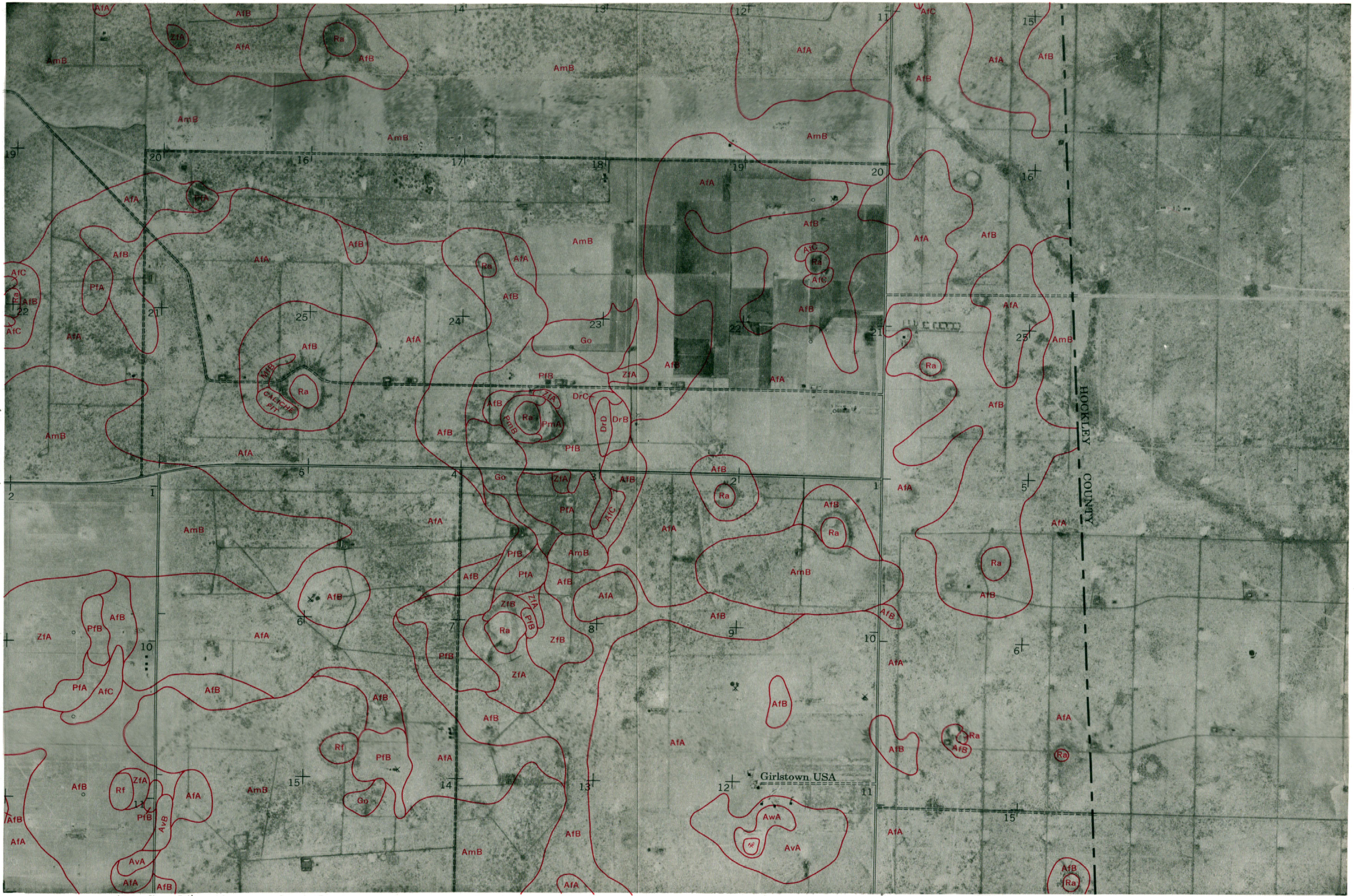
Land division corners and numbers shown on this map are indefinite

(Joins sheet 42)

COCHRAN COUNTY, TEXAS—SHEET NUMBER 48

N

(Joins sheet 47)



(Joins sheet 54)

0 ½ 1 Mile

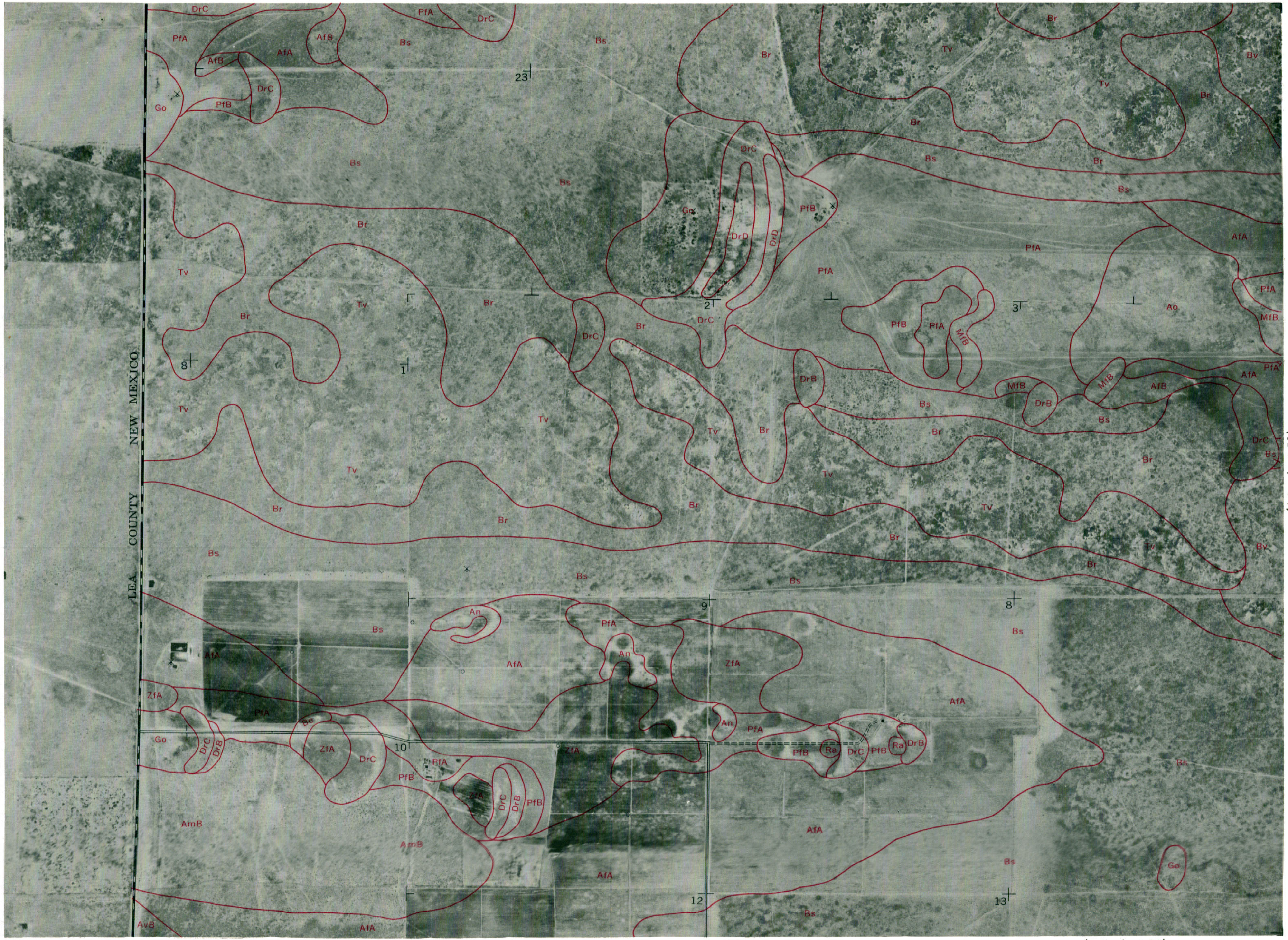
Scale 1:20000

0 5000 Feet

COCHRAN COUNTY, TEXAS—SHEET NUMBER 49

49

(Joins sheet 43)



N

(Joins sheet 50)

(Joins sheet 55)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

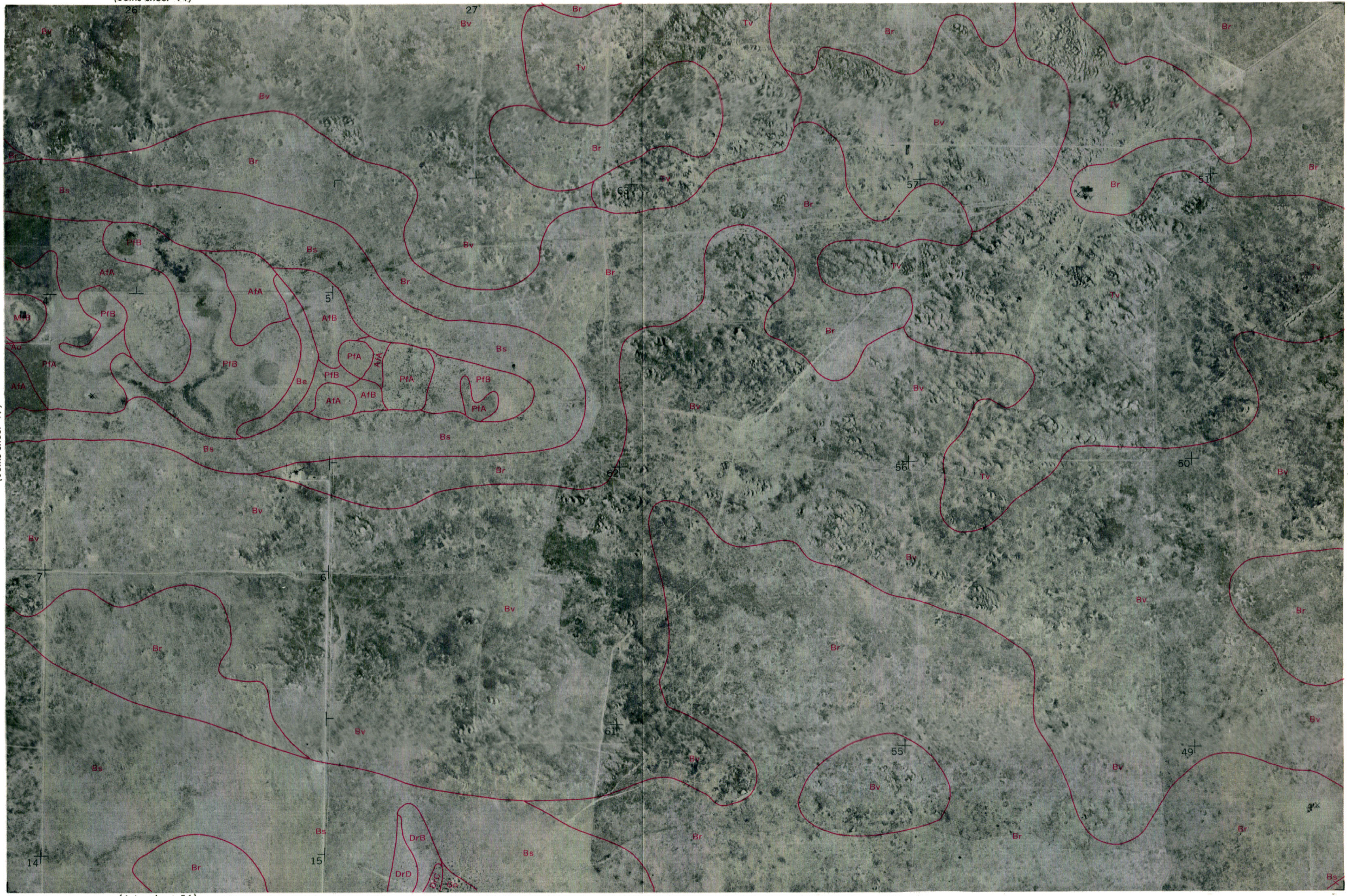
This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite

COCHRAN COUNTY, TEXAS—SHEET NUMBER 50

(Joins sheet 44)

(Joins sheet 49)



(Joins sheet 51)

(Joins sheet 56)

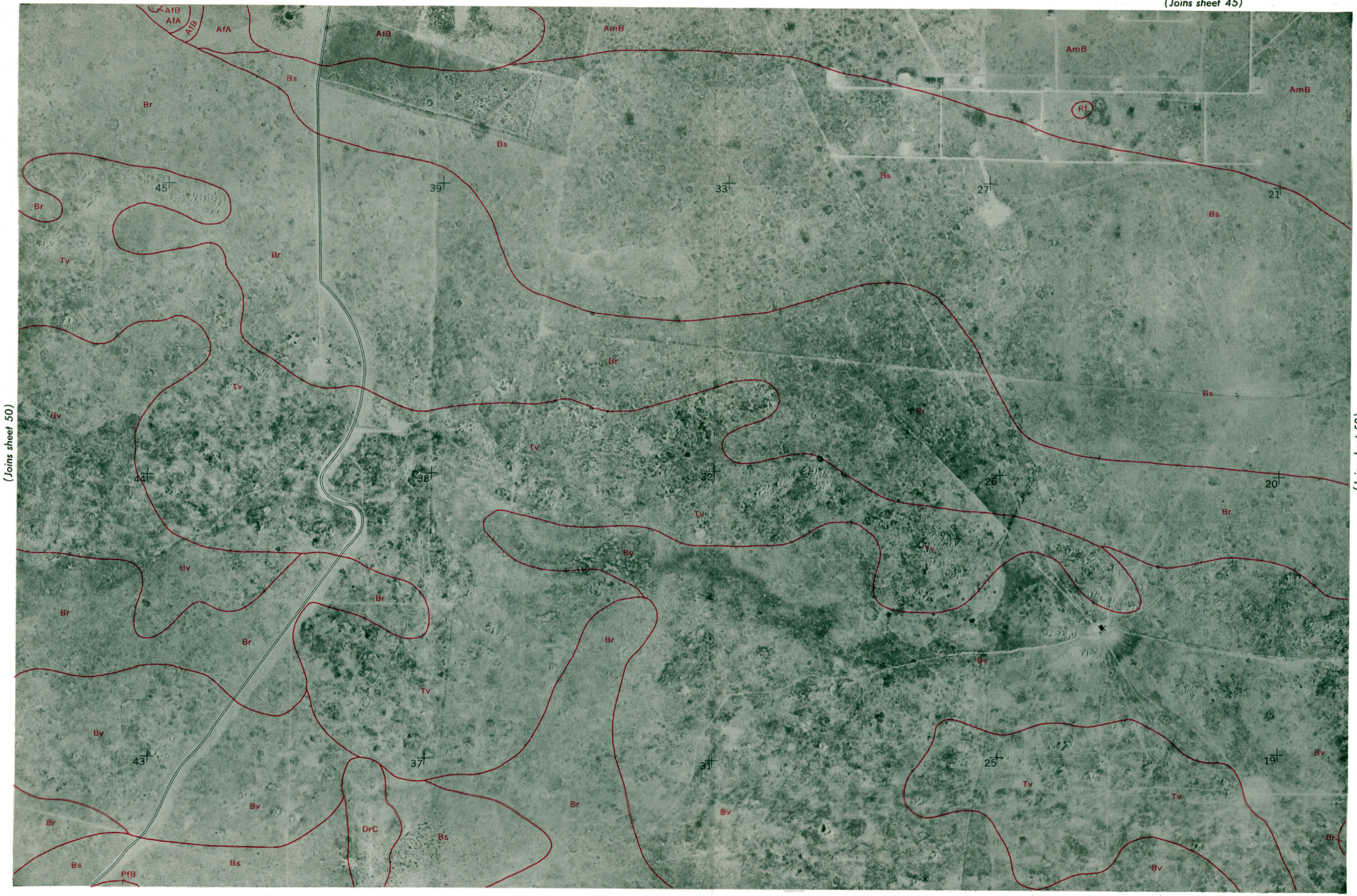
0 ½ 1 Mile Scale 1:20000 0 5000 Feet

(Joins sheet 45)

51

N

(Joins sheet 50)



(Joins sheet 52)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

(Joins sheet 57)

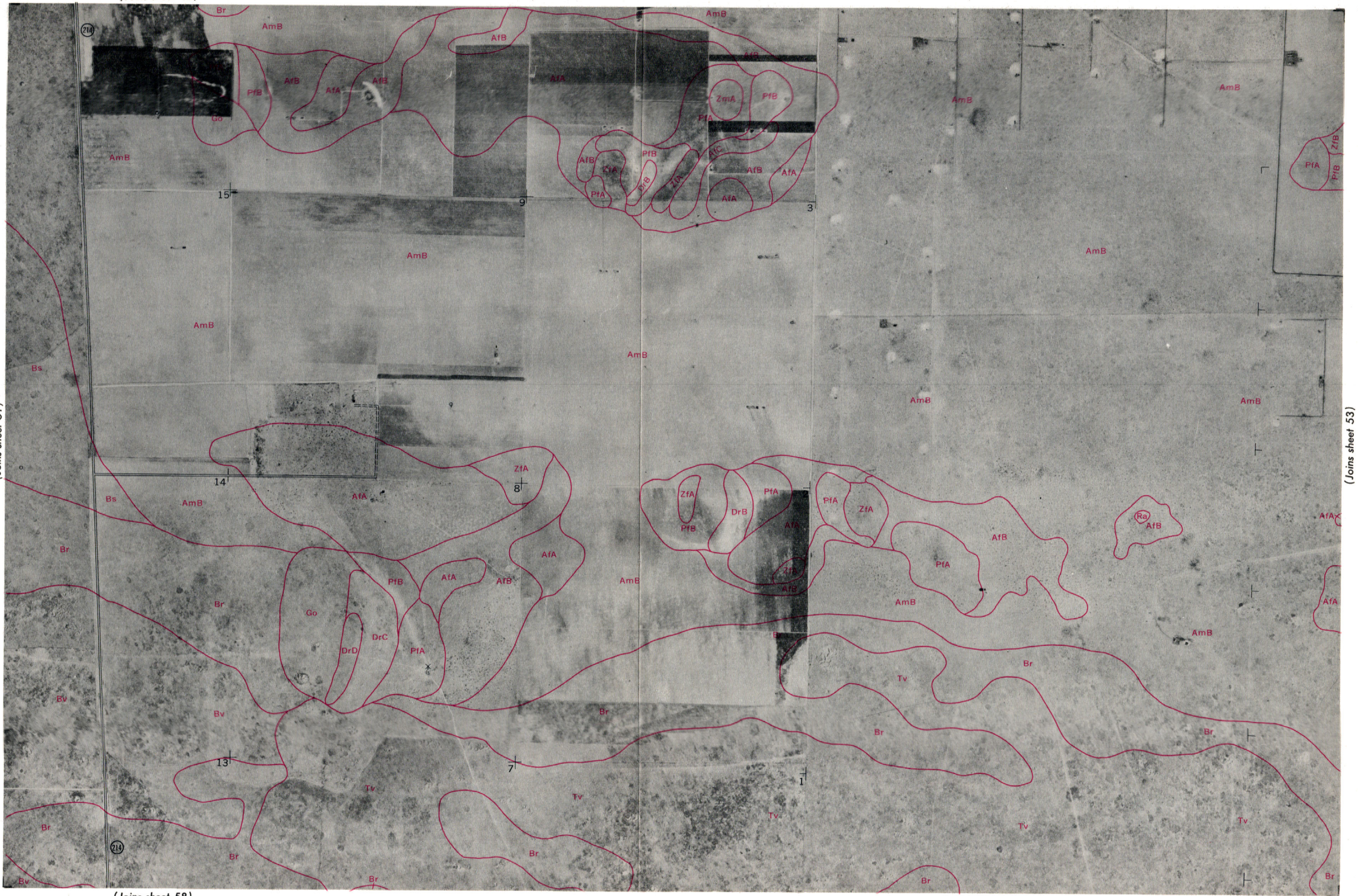
This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite

COCHRAN COUNTY, TEXAS—SHEET NUMBER 52

(Joins sheet 46)

(Joins sheet 51)



(Joins sheet 53)

(Joins sheet 58)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

COCHRAN COUNTY, TEXAS—SHEET NUMBER 53

53

(Joins sheet 47)

(Joins sheet 52)

(Joins sheet 54)

(Joins sheet 59)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

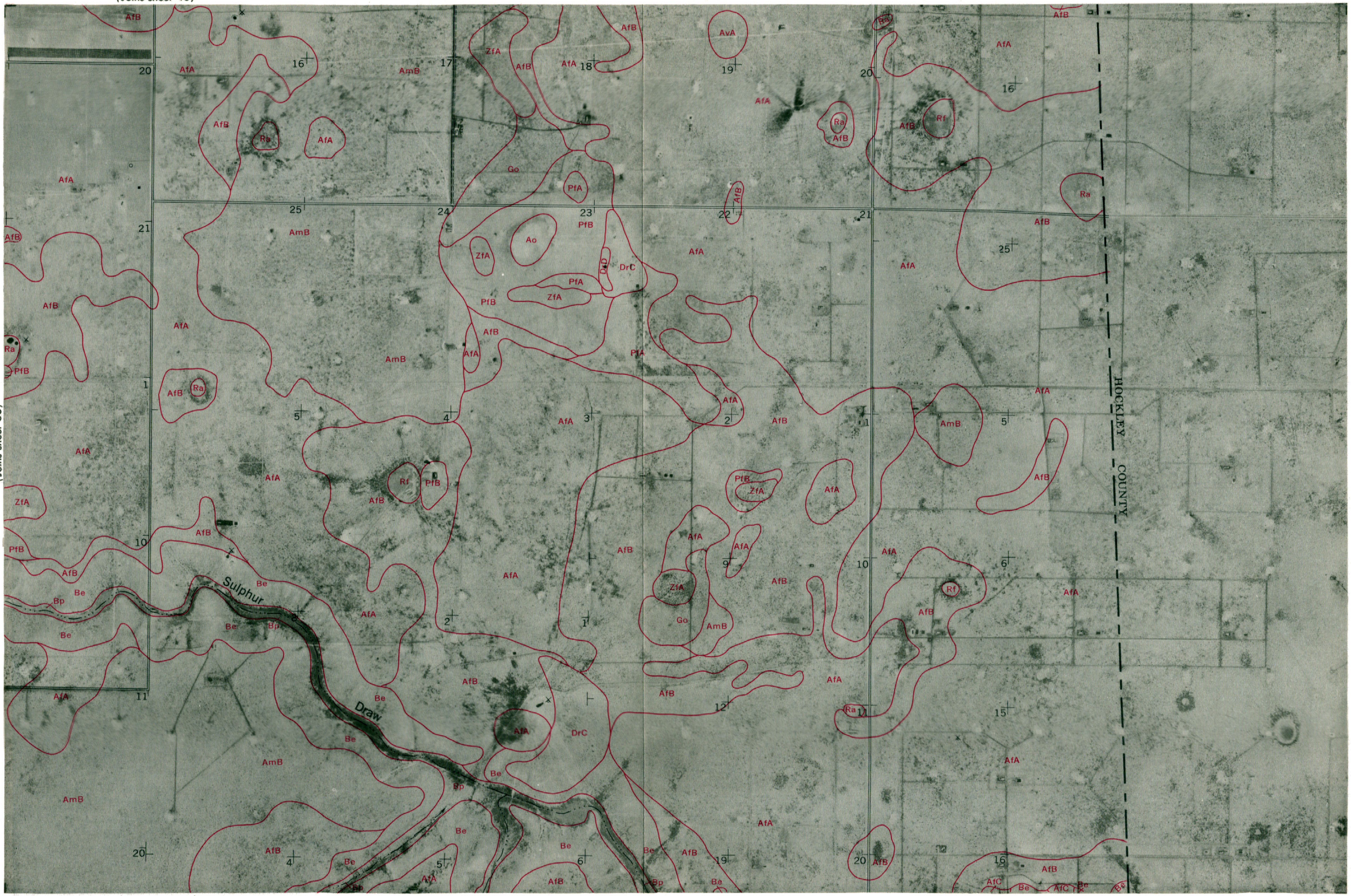
Land division corners and numbers shown on this map are indefinite

54

(Joins sheet 48)

N

(Joins sheet 53)



(Joins sheet 60)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

(Joins sheet 49)

55

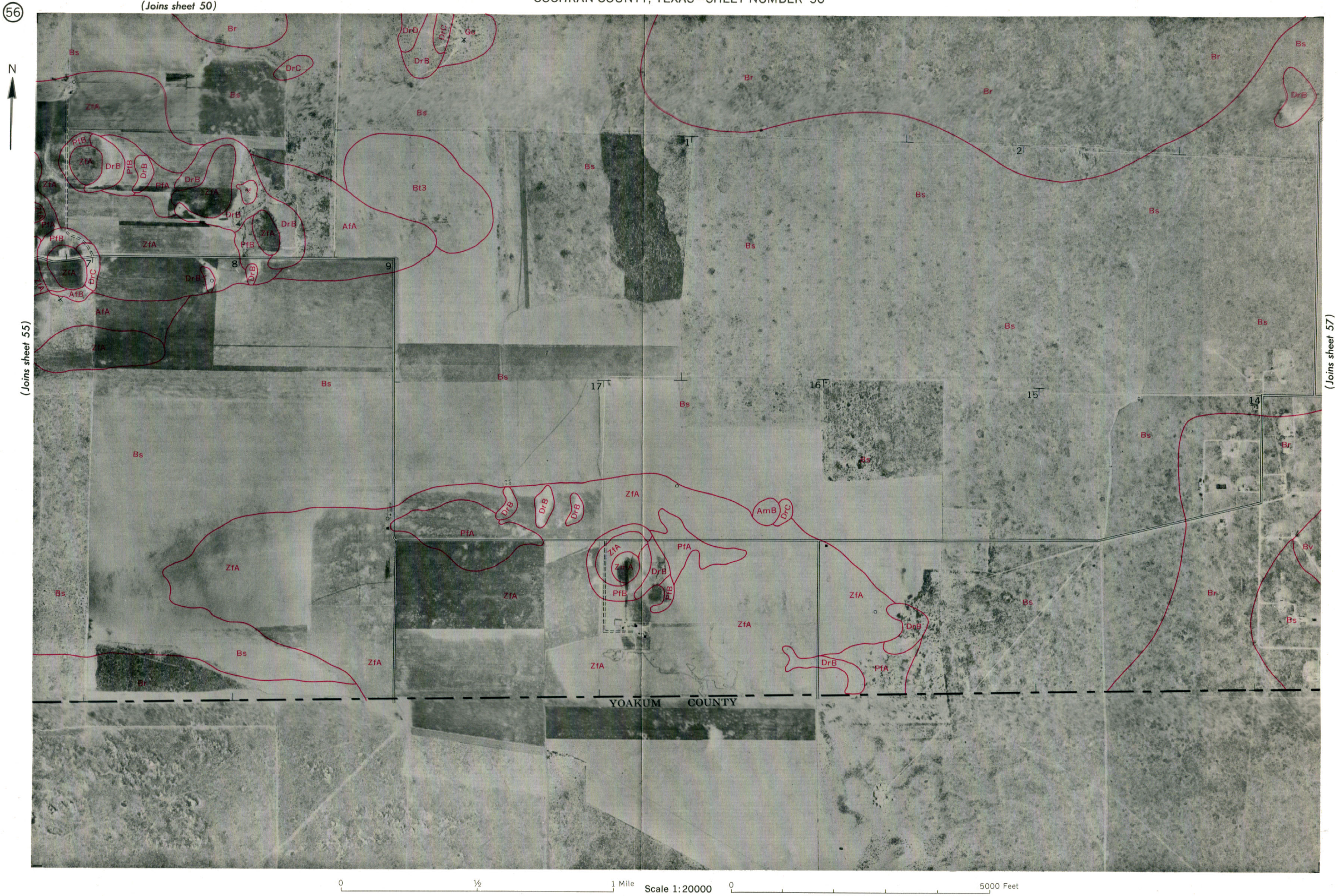
N

(Joins sheet 56)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite


56
(Joins sheet 50)
N
(Joins sheet 55)
(Joins sheet 57)
YOAKUM COUNTY
Br
Bs
DrB
DrC
ZfA
PfB
PfA
AfA
AfB
Bt3
AmB
Bv
1
2
8
9
14
15
16
17
0
½
1 Mile
Scale 1:20000
0
5000 Feet

(Joins sheet 51)

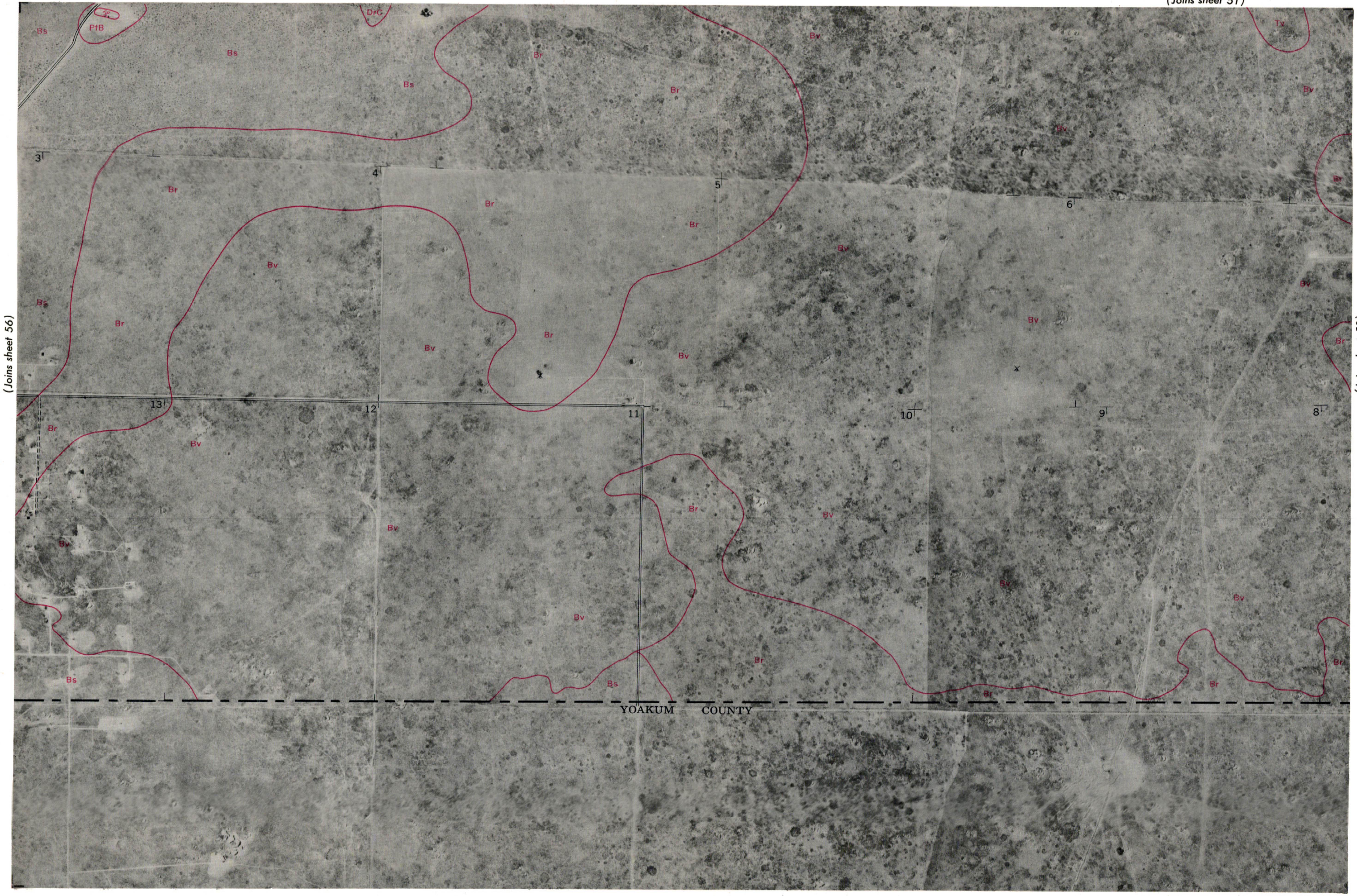
57

N

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners and numbers shown on this map are indefinite

(Joins sheet 56)



(Joins sheet 58)

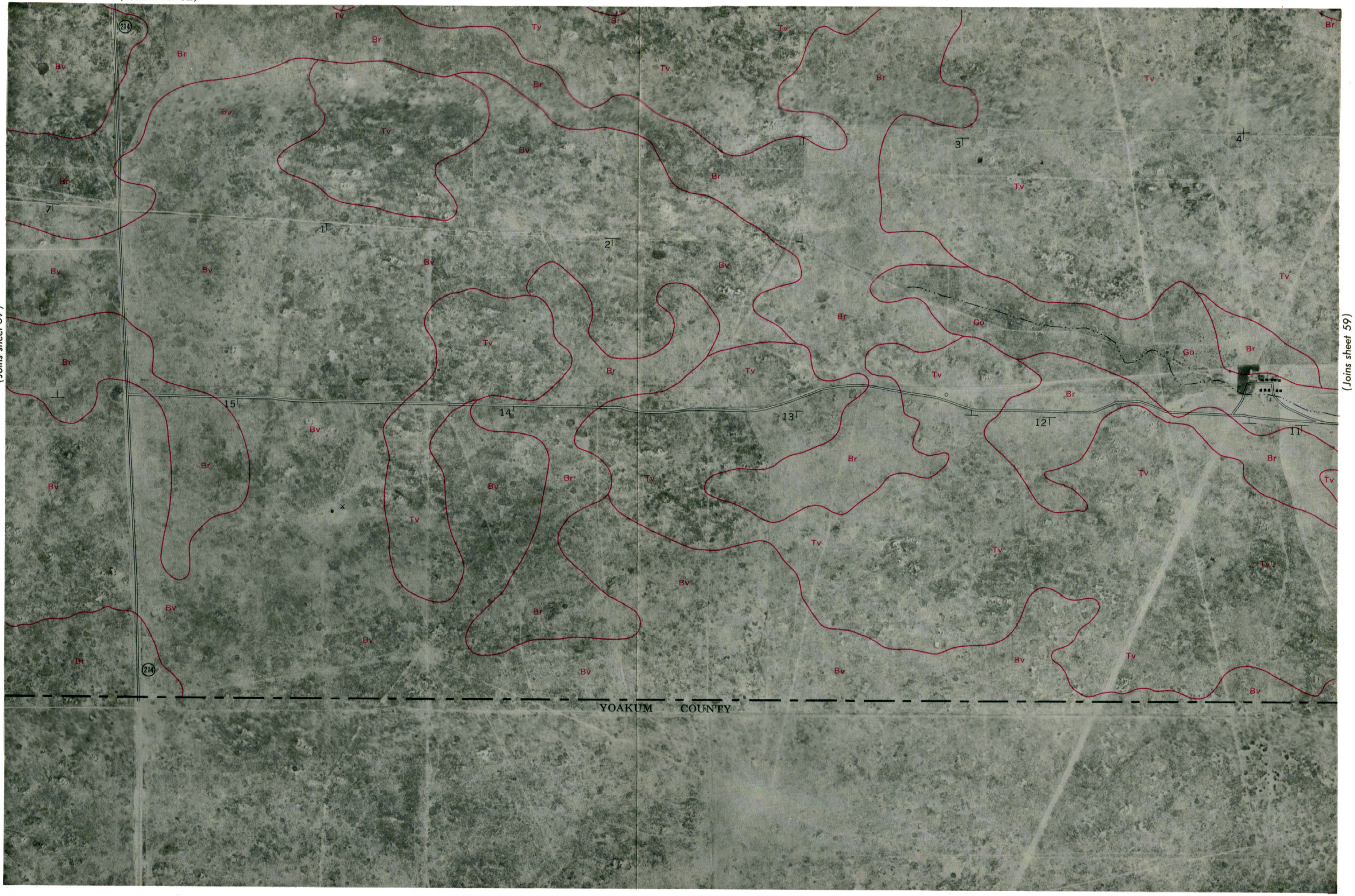
0 ½ 1 Mile Scale 1:20000 0 5000 Feet

COCHRAN COUNTY, TEXAS—SHEET NUMBER 58

(Joins sheet 52)

N

(Joins sheet 57)



(Joins sheet 59)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

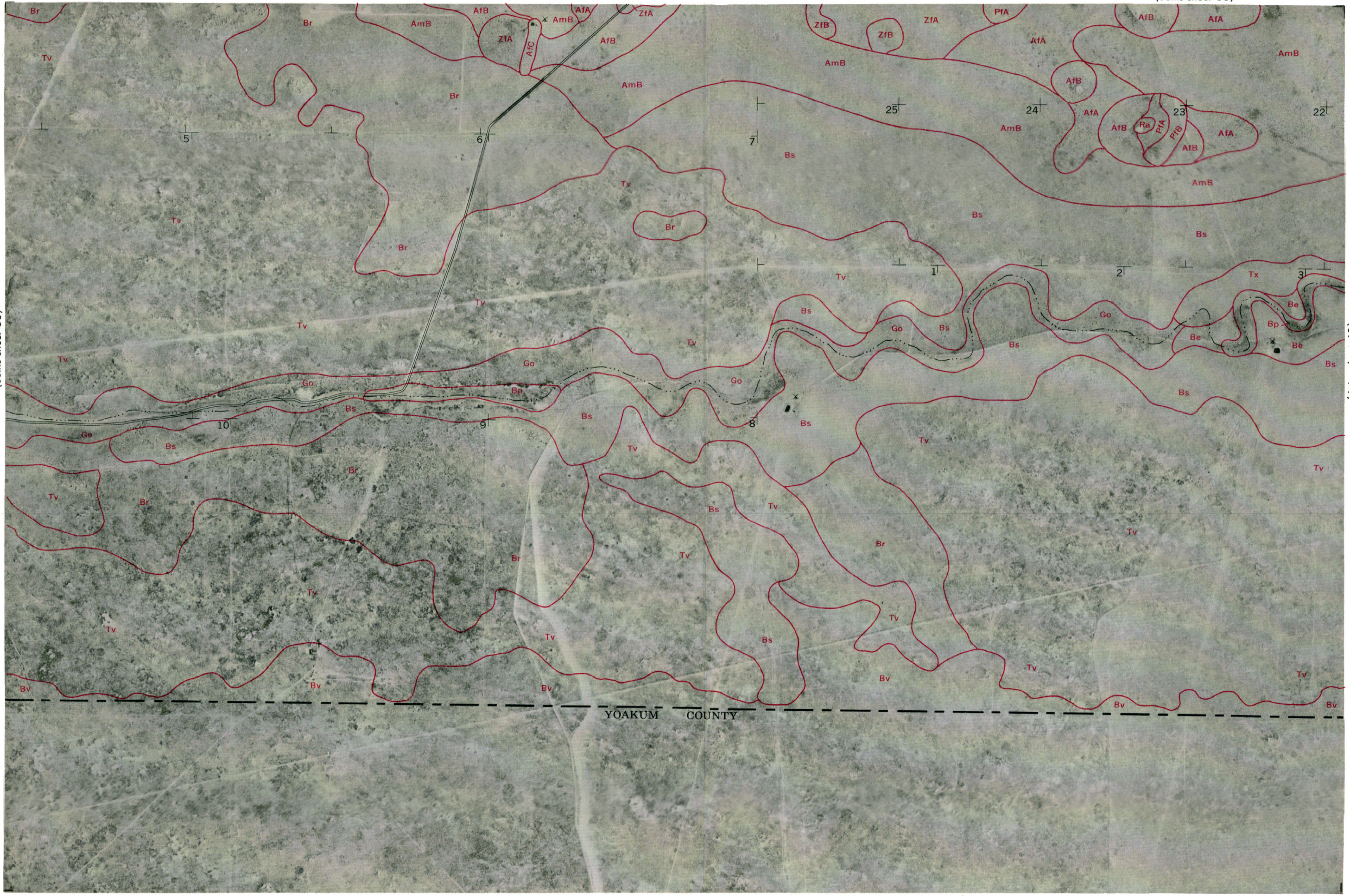
COCHRAN COUNTY, TEXAS—SHEET NUMBER 59

(Joins sheet 53)

59

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

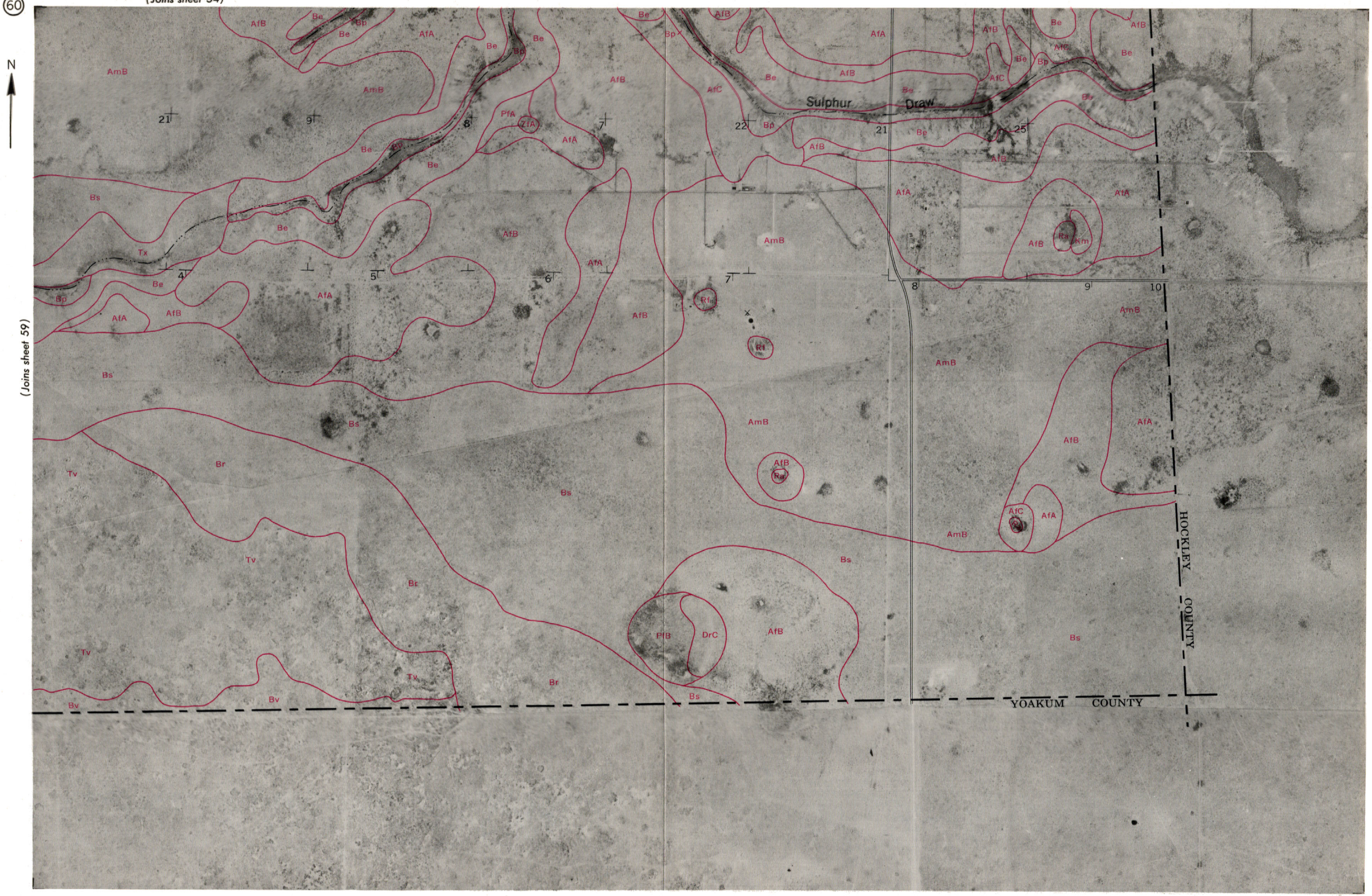
Land division corners and numbers shown on this map are indefinite



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

(Joins sheet 54)

COCHRAN COUNTY, TEXAS—SHEET NUMBER 60



0 ½ 1 Mile Scale 1:20000 0 5000 Feet